SEP 26 1958

SEPTEMBER, 1958

PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

THE LIBRARY OF CONGRESS
SERIAL RECORD
SEP 29 1958

EXTRUDERS

Facts On 1958 Models

A BILL BROTHERS PUBLICATION

Your tooling resin formulator can help you

In an ever-widening range of production applications, tools and dies made with Epon resin-based formulations are giving outstanding service . . . and providing considerable savings compared to the cost of conventional tooling.

If you are concerned about the high cost of conventional tooling—your tooling resin formulator will show you how to get the most out of durable, impact-resistant Epon resin tools. His skill and knowledge, combined with Shell Chemical's years of experience and research, can mean more profitable production for *you*.

High-temperature tooling. Both metal and plastic forming tools, capable of operating at temperatures between 400°F. and 500°F., can be made with Epon 1310.

Long-lasting metal forming tools. Test results show that a casting of an Epon resin formulation mounted in a crank press and subjected to repeated blows had no permanent deformation after 28,000 cycles.

Excellent tolerances. Little machining and handwork are required to finish Epon resin tools, because the material can be fabricated to very close tolerances.

Outstanding strength. Tools with thin cross sections can be laminated with layers of glass cloth and Epon resin to achieve high flexural strength, and dimensional stability.

Can Epon resin help you with your tooling? Find out now by writing your tooling resin formulator. For a list of tooling resin formulators and further information on Epon resin, write to Shell Chemical.

SHELL CHEMICAL CORPORATION

CHEMICAL SALES DIVISION

Atlanta • Boston • Chicago • Cleveland • Detroit • Houston • Los Angeles • Newark • New York • San Francisco • St. Louis

IN CANADA: Chemical Division, Shell Oil Company of Canada, Limited, Montreal • Toronto • Vancouver

SHELL

PLASTICS TECHNOLOGY, published monthly by PLASTICS TECHNOLOGY PUBLISHING CORP., a division of BILL BROTHERS PUBLISHING CORPORATION. Office of Publication, Third and Hunting Park Avenue, Philadelphia, Pa., with Editorial Executive Offices at 386 Fourth Avenue, New York 16, N. Y. Subscriptions in United States and possessions and Canada $5.00 per year. All other countries $10.00. Accepted as controlled circulation publication at Philadelphia 1, Pa. Copyright 1958 by Plastics Technology Publishing Corp. Please send change of address to the New York office.

26 1958

Thermolite®
VINYL STABILIZERS

for clarity...
heat stability...
light stability...

IN
RIGIDS · FLEXIBLES
FILMS · SHEETING · PLASTISOLS
ORGANOSOLS

ORGANOTINS

Most closely approach the requirements of an ideal stabilizer by giving outstanding clarity, insuring excellent heat and light stability. Wide range of the stabilizers permits the selection of a type for your specific use.

THERMOLITE 12 — for all applications requiring moderate heat stability and good light stability . . . has lubricating properties . . . optical clarity in all vinyl resins.

THERMOLITE 13 — powerful heat stabilizer with dienophilic properties for processing vinyls at high temperature.

THERMOLITE 17 — outstanding light stabilizer, especially for plastisols and organosols . . . vinyls are crystal clear.

THERMOLITE 20 — sulfur-containing . . . for rigid vinyls. Has excellent lubricating qualities and good heat stability.

THERMOLITE 25 — outstanding all-purpose stabilizer for rigids, flexibles and plastisols.

THERMOLITE 31 — most powerful stabilizer known . . . unexcelled for rigids, either clear or pigmented.

THERMOLITE 45 — low cost, for processing copolymer rigids . . . no water pick-up in clear vinyl hose.

LIQUID BARIUM-CADMIUM

THERMOLITE 112 — this new concept in barium-cadmium stabilizers contains no fatty acids or octoates. Outstanding compatibility insures no "plate out". Excellent clarity, heat stability and light stability in all vinyl applications. Low viscosity in plastisols. Film and sheeting made with Thermolite 112 has excellent printing and heat-sealing characteristics.

AUXILIARY STABILIZERS

THERMOLITE 166 — liquid-zinc stabilizer for use with Thermolite 112 to improve initial color, prevent sulfur staining and reduce viscosity in plastisols.

THERMOLITE 180 — purely organic stabilizer for use with all metallic stabilizers. Powerful antioxidant properties prevents yellowing during processing.

METAL & THERMIT CORPORATION

GENERAL OFFICES: RAHWAY, NEW JERSEY

METAL & THERMIT — UNITED CHROMIUM OF CANADA, LIMITED • REXDALE, ONT.

Complete information on THERMOLITE stabilizers is available on request.

these thermatic Series* extruder

features mean higher production on every job!

Simplified one piece cylinder with integrally cast-in Xalloy liner.

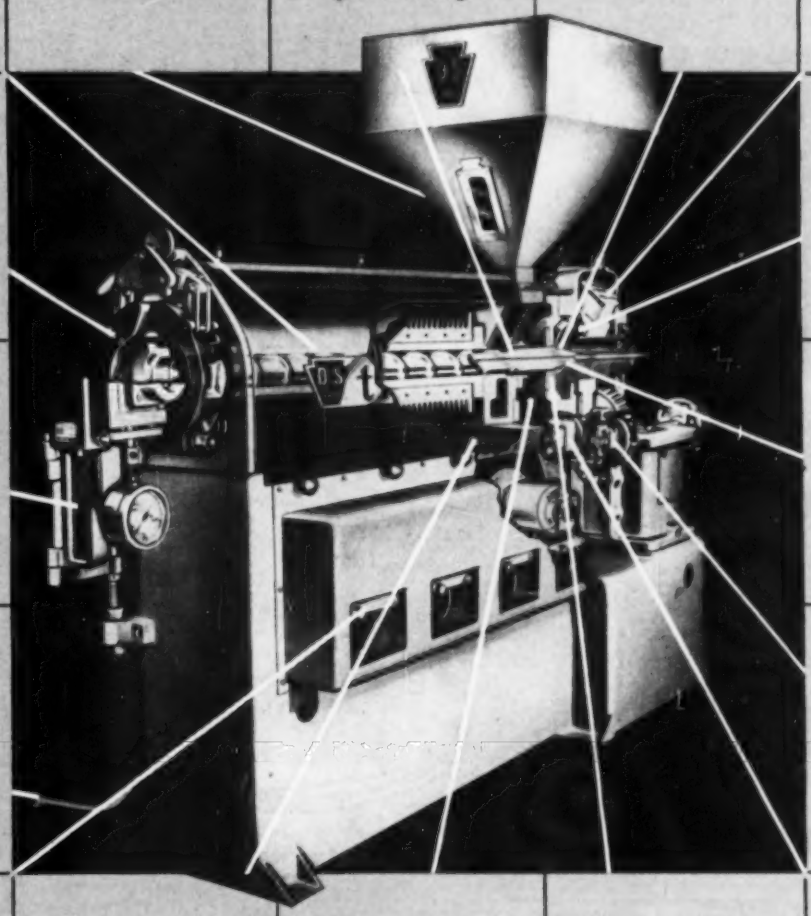
Extra large capacity stainless steel hoppers.

Screw flight extends back beyond the feed throat opening for improved powder and granule feeding.

Four-spline screw drive eliminates the eccentric screw rotation of a single key drive.

Helical gearing — smooth, efficient, free-running. Greatly increased horsepower capacity.

New stronger head clamp. Simplified opening and closing of head with positive safety shear pin arrangement.



Higher thrust bearing capacity. Extra-heavy separate thrust and radial bearings handle their respective loads individually to meet constantly increasing production requirements.

Improved hinged head support swings completely clear of the front of the extruder.

Tapered drive end of stock screw positively centers screw and simplifies removal.

Heaters and controllers completely wired for fast inexpensive installation.

Gear type oil pump, positively driven from input shaft, lubricates all bearings and gears regardless of speed.

Damper arrangement provides several gradients of natural draft cooling. Blowers provide high circulation for stubborn cooling jobs.

Air-tight oven effect adjustment by new second set of dampers for high temperature extrusion.

Access opening allows easy replacement of bronze feed throat bushing.

Labyrinth oil seals — simple non-wearing design. No oil seals or rings to replace.

Built-in direct drive stock screw electric tachometer.

Greater cylinder lengths standard on all extruder sizes with optional L/D ratios available. **2½", 3½", 4½", 6" and 8" models available.** The New D-S thermatic Series Extruders will outproduce — size for size — any other extruder on the market today. For complete specifications and details write to:

D-S

DAVIS - STANDARD

Division of FRANKLIN RESEARCH CORPORATION

16 WATER STREET, MYSTIC, CONNECTICUT

*Patented

IN CANADA CONTACT E. V. LARSON CO. LTD., 572 QUEEN STREET EAST, TORONTO 2, ONTARIO
IN EUROPE AND THE STERLING AREA CONTACT FAWCETT, PRESTON & CO. LTD., BROMBOROUGH, ENGLAND

SEP 29 1958

PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

SEPTEMBER 1958 VOLUME IV NUMBER 9

FEATURE ARTICLES:

805 **INFLUENCE OF RESIN AND PROCESS VARIABLES ON POLYESTER-GLASS LAMINATE PROPERTIES** *A. L. Smith and W. G. Carson*

Experimental data describe the controlled effects of several resin properties, including modulus of elasticity.

812 **HEALTH SAFETY OF PLASTICS** *D. D. McCollister and W. J. Sauber*

A review and discussion of the underlying principles for food-contact applications.

831 **RELIABLE PROPERTIES CAN BE GUARANTEED** *R. S. Jackson*

Statistical control methods reduce costs, make efforts more productive, and accelerate product and process improvements in both large and small plants.

GUEST EDITORIAL:

815 **RESEARCH: THE KEY TO THE PLASTICS CRISIS** *A. E. Gabriel*

SPECIAL FEATURE SECTION:

817 **WHAT A PLASTICS ENGINEER SHOULD LOOK FOR WHEN PLANNING TO BUY AN EXTRUSION MACHINE** *R. E. Monica*

819 **P.T.'S COMPARATIVE DATA ON EXTRUSION MACHINES**

ENGINEERING COLUMN:

836 **EXPLORING FABRICATION TECHNIQUES** *L. J. Zukor*

ENGINEERING FORUM:

839 **MOLDMAKING AND TOOLING** *Ernest J. Csaszar*

840 **REINFORCED PLASTICS** *Harry T. Douglas*

841 **COMPRESSION AND TRANSFER MOLDING** *Paul E. Fina*

FEATURE STORIES:

841 **FINA ON PT EDITORIAL ADVISORY BOARD**

829 **VACUUM-FORMING WITH EPOXY RESIN MOLDS**

FEATURE DEPARTMENTS:

774	Letters to the Editor	853	New Materials
775	"Quote . . . Unquote"	855	New Equipment
785	Editorial	858	Plastics Applications
789	News in Brief	860	New Literature
842	News of the Societies	862	Book Reviews
843	News of the Industry	865	Abstracts of Important Articles
850	Names in the News	869	Patent Digest
851	News from Abroad	871	Resins: Production & Sales

870 Price List

ROBERT B. CARTER
Publisher

ARTHUR M. MERRILL
Editor

JAMES T. DUGAN
Managing Editor

LEE J. ZUKOR
Engineering Editor

CHARLES C. ORR
Assistant Editor

DR. JAY GOULD
Market Statistics

L. THAKAR
Foreign Editor

ROBERT G. SEAMAN
Consulting Editor

FLORENCE NEWMARK
Editorial Assistant

FRANCES Y. McHUGH
Production Manager

EDITORIAL ADVISORY BOARD

Materials
C. H. ADAMS
R. L. KNAPP
A. P. LANDALI
G. B. THAYER

Moldmaking
E. J. CSASZAR

Equipment
E. H. JOHNSON
E. B. STRATTON
W. H. WILLERT

Processing
SAUL BLITZ
H. T. DOUGLAS
P. E. FINA
G. S. LAAFF

BUSINESS STAFF

JOHN W. MacVITTIE, JR.
Eastern Sales Manager
386 Fourth Avenue
New York 16, N. Y.
LExington 2-1760

WILLIAM T. BISSON
Mid-West Sales Manager
163 West Exchange Street, Room #7
Akron 8, Ohio
FRanklin 6-3434

C. E. LOVEJOY, JR.
Western Manager
TOM McDONOUGH
Sales Representative
333 N. Michigan Ave., Chicago 1, Ill.
STate 2-1266

ROBERT E. AHRENSDORF
Pacific Coast Representative
5720 Wilshire Blvd., Los Angeles 36
MAdison 9-2681
260 Kearny Street, San Francisco 8
EXbrook 7-0690

ALBERT R. WILSON
Circulation Manager

JOHN W. HARTMAN
President

FREDERICK C. KENDALL
Vice President

Chairman of the Board, Philip Salisbury, President, John W. Hartman, Treasurer, Ralph L. Wilson, Vice Presidents, B. Brittain Wilson, C. E. Lovejoy, Jr., Wm. H. McCleary. Editorial and Executive Offices, 386 Fourth Ave., New York 16, N. Y. LExington 2-1760. Subscription Price: United States and Possessions and Canada, $5.00 per year. All other countries, $10.00. Single copies in the U. S., 50¢; elsewhere, 75¢. Other Bill Brothers Publications: In Industry: Rubber World. In Marketing: Sales Management, Sales Meetings, Tide, Premium Practice. In Merchandising: Floor Covering Profits, Fast Food, Tires-TBA Merchandising Members of Business Paper Audit of Circulations, Inc. and National Business Publications, Inc.

NBP BPA

PUBLISHED MONTHLY BY

Plastics Technology Publishing Corp., a Division of

BILL BROTHERS PUBLICATIONS

BILL BROTHERS PUBLISHING CORPORATION

386 FOURTH AVENUE, NEW YORK 16, N. Y.

The opinions expressed by our contributors do not necessarily reflect those of our editors

Letters to the Editor

Previews of Next Month

The following articles will be published in the October issue:

Determining Molecular Weights of Thermoplastic Materials. W. T. Blake, V-P & Genl. Mgr., C. W. Brabender Instruments, Inc., South Hackensack, N. J.

•

Creep Characteristics of Laminated Epoxy Plastics. John Delmonte, Genl. Mgr., Furane Plastics, Inc., Los Angeles, Calif.

•

NOL Ring Test for Glass Roving-Reinforced Plastics. P. W. Erickson, Sr. Proj. Engr., I. Silver, Chief, Non-Metallic Matls. Div., and H. A. Perry, Jr., Consultant, Non-Metallic Matls., U. S. Naval Ordnance Lab., Silver Spring, Md.

•

Fabricating the Structural Components of the All-Plastic "House of the Future." C. G. Cullen, Proj. Engr., Winner Mfg. Co., Trenton, N. J.

•

The Guest Editorial will be **"Let's Tell the People,"** by Betty L. Raskin, Head of Radiation Research, Johns Hopkins U., Baltimore, Md.

•

Highlights of This Issue

Influence of Resin and Process Variables on Polyester-Glass Laminate Properties. (p. 805)

Experimental data are given showing that a resin should have high modulus and strength for best laminate properties. Polymerization shrinkage should be high, without causing internal stresses, and resin reactivity should be controlled to avoid too-rapid curing and prevent stress cracking.

Health Safety of Plastics. (p.812)

Safety evaluation of plastics includes extraction, toxicity, toxicological, and legal studies of the problems involved.

Reliable Properties Can Be Guaranteed. (p. 831)

The most important single approach to securing the desired quality level for plastics products. Some techniques available for coping with variability and interaction between variables are discussed in detail, with emphasis on the value of the statistical approach.

What a Plastics Engineer Should Look For When Planning to Buy an Extrusion Machine. (p. 817)

Careful planning on the part of the plastics engineer pays dividends in future operation of the plastics extrusion machine. Subjects to be considered include manufacturer's specifications for extruders, auxiliary equipment, customer service and maintenance, plant lay-out, and financial considerations for the buyers.

Information Wanted

Dear Sir:

We use a stencil tape in the printing of words on our player piano rolls.

Presently, we are seeking a substitute for the stencil rolls with a very minimum of thickness plus tensile strength to allow a speed-up of the printing process.

We would appreciate your advising us of any possible suppliers.

O. Dahloff
Imperial Industrial Co.
New York, N. Y.

•

Dear Sir:

We are in the buying market for small, hinged, plastic pill boxes in Luten colors, in 50,000 and 100,000 quantities, in size 1 x 1 x ½. Will you see that firms that make or stock them write us with samples and prices.

H. R. Shapiro, Owner
National Soap & Chemical Co.
Los Angeles, Calif.

•

Dear Sir:

Will you please supply us with the names and addresses of the various manufacturers of honeycomb material?

J. S. McGuire, Pres.
Fairfax Engineering Co.
Kansas City, Kansas

•

Dear Sir:

I am trying to obtain information on imbeddiments in clear plastic, on a production basis. Could you recommend someone who would have information on this?

Melvin Budish
Auto-Mold Co., Inc.
Worcester, Mass.

•

Dear Sir:

We are manufacturing and selling a packaged urethane foam to the various boat manufacturers. This is a two-part compound that the user merely mixes and pours. Our material is blown or foamed in place and adds rigidity and flowtation to boats and other items of a similar nature.

We have been working for some time attempting to develop a closed cell, foamed in place, polyester resin that is under five pounds per cubic foot density, and can be formulated in such a way that the small manufacturer or layman can foam in place. In the event that someone else is already doing this, we would be very interested in purchasing the material.

We have been unable to obtain any literature or information of any kind that could be of assistance to us. Could you possibly give us some information either from your readers or your research department on foaming polyester resins? We hope that possibly some of your readers may be able to help us.

Leonard Graff, Gen. Mgr.
Arlee Foam Rubber Prods., Inc.
Gardena, Calif.

•

Dear Sir:

I am interested in the fabrication of plastics, particularly rigid plastic sheets. I would like information concerning how to fabricate these sheets.

Any information you can give me will be appreciated.

W. R. Redding, II
Knoxville, Tenn.

•

Dear Sir:

Could you direct us to a maker of fiberglas siding for houses?

Arthur Dunham
Craft Shop
Wyandotte, Mich.

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation and address.

A letter will not be printed if publication is not desired by the sender, and the identity of the writer will be withheld, if desired.

—The Editor

"Quote . . . Unquote"

American Science and Education

"In this country, we have emphasized the application of science to the production of things for our material welfare. We have even been accused, from time to time, of confusing scientific achievement with the production of egg beaters and carwashing compounds. I cannot dismiss utilitarian goals as unworthy of scientific application. It is indeed the ubiquitous nature of our scientific effort which stands in contrast with science as practiced in other countries, and particularly in the Soviet Union.

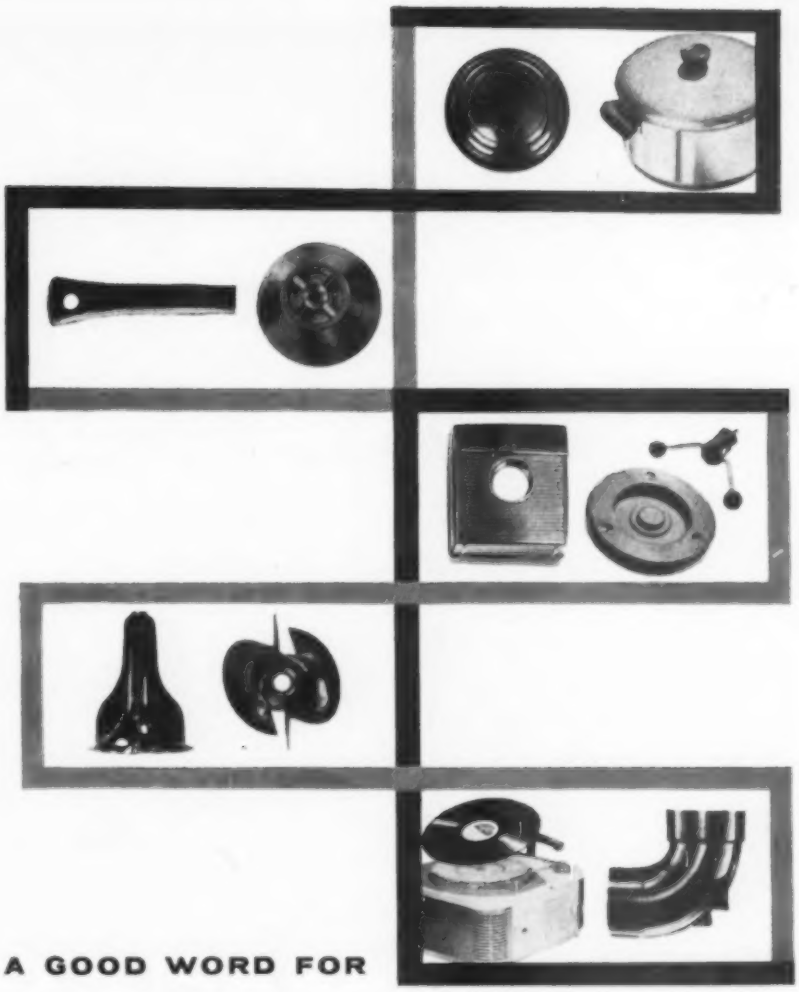
"American science is not a weapon, its edge sharpened for military aggression, but a plowshare tilling the peaceful fields of our normal lives. It has been well demonstrated that our capacity to produce in time of peace is our greatest weapon in time of emergency of war. Hence, strength in war, strength in peace, and strength in science become synonymous.

"I would not agree that Soviet science generally has outstripped our own. Effort in a given area to the exclusion of all others can doubtless produce an occasional extraordinary result, and the satellites would not worry us were it not for their frightening military implications and the suspicions we entertain of Soviet motivations. It is entirely foreign to our natures and to our traditions to be driven to exclusive emphasis on one objective, and particularly a military objective. We have learned that sound progress is progress that rests on the free advance of human knowledge in all of its many inter-related disciplines. Herein lies our strength, and I am certain that our scientific sinews are fully adequate to prevail in the long run, whatever short-term setbacks we may encounter.

"Just as the satellites have caused us to appraise our competitive stature, so have they brought us to a searching examination of our educational establishment. There is some feeling today that the American school and college system has fallen short of other nations, particularly with the Soviet Union. Surely, there is always merit in sober appraisal and careful analysis, but I cannot agree that there is anything fundamentally wrong with our educational institutions, nor that they suffer unduly by comparison with the educational process in other countries. It seems to me that here again the question is not a comparison of educational communities, but the more significant comparison of free institutions with the authoritarian power.

"We have dedicated ourselves to the doctrine that education is one of the necessities of life."

C. H. Greenewalt, Pres.
E. I. du Pont de Nemours & Co.
Wilmington, Del.



A GOOD WORD FOR

QUALITY PHENOLIC MOLDING COMPOUNDS

IN THEIR WIDEST APPLICATION IS

PLENCO

. . . a good word, too, for dependable counsel. Whether you take our advice or not, you can't help but profit from your consultation with Plenco's problem-solving specialists. And, in production, you can't help but benefit from the wide-ranging knowledge with which these modern molding materials are formulated and the precision with which they are produced.

Does phenolics have the answer for you? Then, chances are that Plenco compounds, in their exceptional variety, versatility and quality-controlled uniformity, can provide it. We invite you to let us demonstrate that.

PLENCO PHENOLICS
FOR BETTER PLASTIC PRODUCTS

Serving the plastics industry in the manufacture of high grade phenolic molding compounds, industrial resins and coating resins.

PLASTICS ENGINEERING COMPANY
Sheboygan, Wisconsin

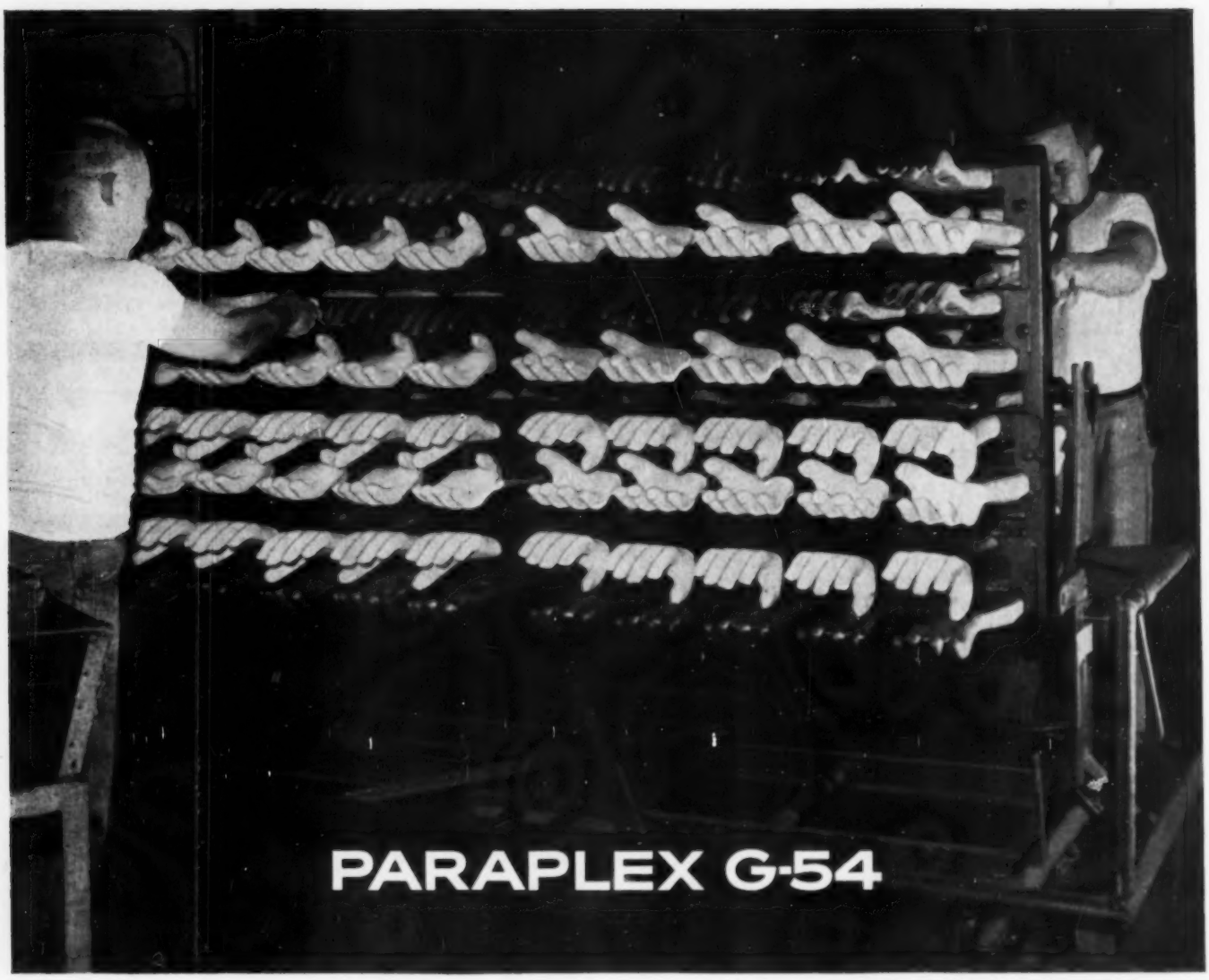


Photo courtesy Edmont Manufacturing Company, Coshocton, Ohio

For grease and solvent resistance in vinyl compounds...

Hot water, soap and detergents, solvents, greases, corrosive materials and abrasives are only a few of the hazards that industrial gloves must withstand to meet service requirements. That's why formulators of vinyl compounds for tough jobs choose PARAPLEX G-54—the polymeric plasticizer that's designed for rough, tough service.

Whether you are making plastisols for dip coating or are interested in gaskets, surgical tapes, high-temperature resistant electrical insulation or general utility vinyl compounds, PARAPLEX G-54 is the best answer to your problem. Check your needs against these outstanding properties that PARAPLEX G-54 gives to vinyl compounds:

1. Retention of compatibility at high humidity and temperature.
2. Resistance to migration in contact with baked enamels, alkyd finishes, nitrocellulose lacquers, polystyrene, rubber and rubber-base materials.
3. Good handling and processing characteristics.
4. Resistance to extraction by soapy water.
5. Superior electrical properties in clay-filled formulations.
6. Modest cost.

Send today for full information about PARAPLEX G-54 and the other versatile members of the PARAPLEX polymeric and MONOPLEX monomeric series.

PARAPLEX AND MONOPLEX *are trade-marks, Reg. U.S. Pat. Off. and in principal foreign countries.*

Chemicals for Industry

ROHM & HAAS COMPANY

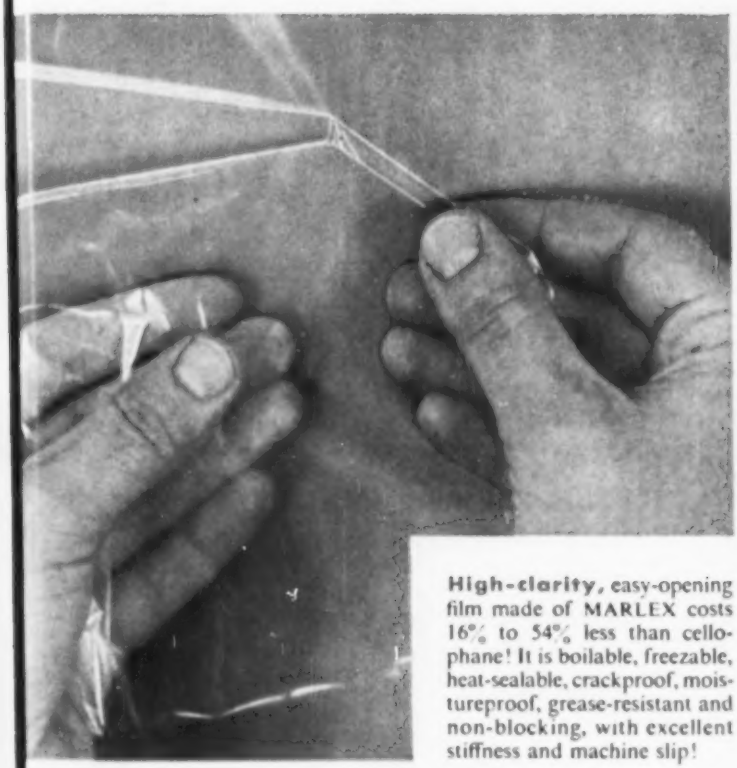
THE RESINOUS PRODUCTS DIVISION

Washington Square, Philadelphia 5, Pa.

Representatives in principal foreign countries

PARAPLEX G-54

How can MARLEX* serve you?



High-clarity, easy-opening film made of MARLEX costs 16% to 54% less than cellophane! It is boilable, freezable, heat-sealable, crackproof, moistureproof, grease-resistant and non-blocking, with excellent stiffness and machine slip!

Durable and corrosion-proof . . . These attractive, new post lanterns made of MARLEX are really durable . . . won't rust and never need painting! They stand up well in any weather, even in damp salt air or smog!

Light and strong... Here at last is a strong, *lightweight*, low-cost marine hawser! Rope made of MARLEX *floats on water!* MARLEX filaments have a tensile strength of 50,000 to 130,000 psi, depending on diameter and drawdown.

Tough and rigid . . . Lightweight MARLEX tote boxes and trays have what it takes for rugged service in restaurants and institutions. They don't splinter, dent or stain . . . and they withstand repeated freezing and steam cleaning.

*MARLEX is a trademark for Phillips family of olefin polymers.

PHILLIPS CHEMICAL COMPANY, Bartlesville, Oklahoma

A subsidiary of Phillips Petroleum Company

PLASTICS SALES OFFICES

NEW ENGLAND	NEW YORK	AKRON	CHICAGO	WESTERN	SOUTHERN
322 Waterman Avenue, East Providence 14, R. I. GEneva 4-7600	80 Broadway, Suite 4300 New York 5, N. Y. Digby 4-3480	318 Water Street, Akron 8, Ohio FRanklin 6-4126	111 S. York Street, Elmhurst, Ill. TErrace 4-6600	317 N. Lake Ave., Pasadena, Calif. RYan 1-0557	6010 Sherry Lane Dallas, Texas EMerson 8-1358

MARLEX

versatile

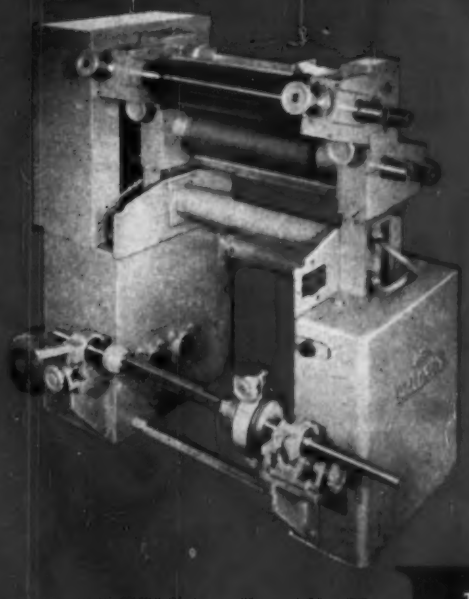
...and a quick change artist

WALDRON multi-coater*

This unit can handle many different operations on a pilot plant or light production basis... operations formerly requiring different machines.

For example, the Waldron Multi-Coater will handle:

- **Reverse Roll Coating—Waldron Type**
- **Reverse Roll Coating—Meadows Type**
- **Impregnating**
- **One Side or Two Side Kiss Coating**
- **Two Web Laminating**
- **Embossing**
- **Gravure Printing**
- **Engraved Roll Coating**
- **Offset Gravure Printing**



Such a unit might be just what you need to carry on your own experimental work. Ask for details. With the necessary accessories, you can make changes from one operation to another easily and quickly. But the main point we wish to emphasize is that to be able to design such a versatile unit implies thorough knowledge of and experience with all the different operations involved and an ability to translate heavy production line requirements into a light duty pilot unit.

Waldron Engineers have this necessary knowledge and this necessary experience.

West Coast Representative:
Bateman-Hunt Machinery Service Co.,
5270 East Washington Blvd.,
Los Angeles 22, California

THE MIDLAND-ROSS GROUP
OF COMPLEMENTING SERVICES

J. O. Ross Engineering, New York
John Waldron Corporation, New Brunswick, N. J.
Andrews and Goodrich, Boston
Ross Engineering of Canada Limited, Montreal
Ross Midwest Fulton, Dayton
Hartig Extruders, Mountainside, N. J.
Cornier Ross Engineering Company, Ltd., England

JOHN WALDRON CORPORATION

A Subsidiary of Midland-Ross Corporation

Leader in Web Process Engineering Since 1827

NEW BRUNSWICK, NEW JERSEY
CHICAGO • LOS ANGELES

U.S.I. POLYETHYLENE NEWS

A series for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

Packaging Notes

Drawstring or Poly Bag has enabled one produce packer to cut labor costs and increase packing speeds 15 per cent. The drawstring runs through a strong, heat-sealed hem on 5-lb. bags of 2 mil polyethylene film. The closure is strong enough for the string loops to be hung on overhead conveyors or used by customers as a convenient carrying handle. The bags require less film to fabricate than do tied-top bags and they are claimed to be easier to fill. Produce shippers have expressed interest in the drawstring poly bag for packing potatoes and citrus fruit.

Polyethylene Bottle Closure with expandable plug is designed to prevent movement and breakage of pills during shipping and use. The patented closure replaces the usual cotton pad or paper insert ordinarily used with tablet containers.

The polyethylene insert is constructed to double up when the cap is screwed onto a full bottle. As pills are used the insert expands to fill the void and hold the pills in place.

Aside from convenience, the expandable closure is said to be more hygienic than cotton plugs since it is never touched in use. The inserts, used for some time by leading German pharmaceutical firms, are now being introduced in this country.

New polyethylene tablet bottle closure employs flexible insert, left, which snaps into screw cap. Insert expands to hold tablets in place even when bottle is half empty.

Two New Decorative Coatings for polyethylene have been announced recently. One is a new process for vacuum-metallizing polyethylene. Brilliant coatings result, with excellent adhesion even on such items as squeeze bottles. Alcohol-proof top coats can also be applied by the same method.

What is reported to be the first adhesive for flocking polyethylene has been announced by another manufacturer. The new adhesive makes it possible to apply a velour coating to sheet or molded products. The process is expected to find application in packaging cosmetics and quality items such as silverware.

U.S.I. Announces Crystal-Clear Poly Film Produced by Cast-Film Process

Cast PETROTHENE® Film Has Top Transparency and Gloss

A crystal-clear polyethylene film, made by a conventional processing technique adapted to polyethylene film production, was introduced by U.S.I. at the 1958 National Packaging Exposition in New York. The film, made from a U.S.I. PETROTHENE resin, has a level of transparency and gloss unprecedented in polyethylene film.

The production method, called casting, employs equipment typical of the extrusion coating industry. In the process polyethylene is extruded and drawn or cast across a highly polished chrome-plated roll. This casting step greatly improves the optical characteristics of the film. This production method also reduces formation of haze-producing crystals in the matrix of the polyethylene by providing for immediate and even quenching. This further contributes to improved clarity.

Extensive research at U.S.I.'s technical service laboratory indicated that a moderately high density resin would be required to strike a balance between properties which promote clarity and those promoting strength. PETROTHENE 205—with a density of 0.924, melt index of 3.0 and PETROTHENE 239 with a density of 0.929, melt index of 5.0 were selected.

Production Costs About Equal

Although the equipment needed for making cast film is initially more expensive, production costs appear to be competitive with those for conventional extruded film. Production speed for cast film is the same or greater than for other film producing processes.

MIRROR IMAGE? No, but the excellent clarity and gloss of cast PETROTHENE film make it almost believable. It's all done with twins.

Production on laboratory-scale equipment indicates that careful control of die temperature and size of die opening is necessary to assure gauge uniformity. However, with proper operating conditions and careful choice of resin, the resulting film has adequate toughness along with its phenomenal clarity. Widespread application in the packaging industry — where clarity is often a prime consideration — is expected.

Nitrogen Blanketing Aids Polyethylene Processing

Nitrogen blanketing of polyethylene extruder feed helps overcome gels, fisheyes, dark spots and other problems caused by polyethylene oxidation.

The procedure was developed at U.S.I.'s technical service laboratory at Tuscola, Ill. It is based on the idea of excluding oxygen by maintaining an inert gas blanket over the resin entering and inside the machine.

According to Ralph Knight, Manager of U.S.I.'s PETROTHENE Technical Service Department, as a further refinement, inert gas also can be used to blanket the molten polyethylene as it leaves the extruder in order to reduce build-up of oxidized material on the die lips of the extruder. The same principle is applicable to other polyethylene processing methods, such as molding.

Coffee Plants Grown in Black Poly Bags

A promising new use for black polyethylene film is reported from Central America. Black poly bags filled with fertilized soil are being used to grow coffee plants in Guatemala. The film acts as a combination flower pot and mulch.

According to the report, when plants are grown in polyethylene bags, they can be brought to transplanting size in nine months instead of the 18 months formerly required. In 1957, approximately seven million polyethylene bags were used in Guatemala.

IN THIS ISSUE:

P. 2 — Cast PETROTHENE Polyethylene Film

P. 3 — New Resin Density Affects Film Properties

P. 4 — Guide to PETROTHENE Resins

1.5-mil cast polyethylene film made from PETROTHENE 239-27 resin has unprecedented clarity and gloss.

IT'S NEW!
IT'S CRYSTAL CLEAR!
IT'S INEXPENSIVE!

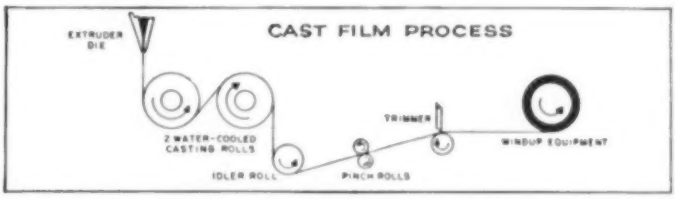
CAST POLYETHYLENE FILM
NOW OUTDATES OTHER TRANSPARENT PACKAGING MATERIALS

Cast polyethylene film—made by a special process employing U.S.I. PETROTHENE® resins—enables you to offer your customers the traditional strength and economy of polyethylene—plus sparkling clarity and gloss. Here's why cast film far surpasses other overwrap materials:

CRYSTAL CLARITY—The new process for making cast polyethylene film produces material with a clarity equal or superior to conventional transparent films. Compare a piece of cast film with ordinary polyethylene film and with transparent films now used for overwrap.

SUPERIOR PACKAGING PROPERTIES—Cast polyethylene film has good impact and tear strength, high grease resistance and is an excellent moisture barrier. It heat seals well and is easily printed. The film doesn't crackle; it has a soft, natural flexibility that adds a look of quality to packaged goods. And handles well in overwrap machinery designed for conventional polyethylene film.

ECONOMY—You can offer your customers substantial savings with cast polyethylene film. It costs less than conventional transparent materials—whether you figure costs per pound or per unit area of film. It is the most inexpensive transparent overwrap material your customers can buy.



To extruders interested in manufacturing cast polyethylene film, U.S.I. will be glad to furnish technical assistance. Contact your nearest U.S.I. office, or write:

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N. Y.
Branches in principal cities

U.S.I.

Vol. III, No. 4

POLYETHYLENE PROCESSING TIPS

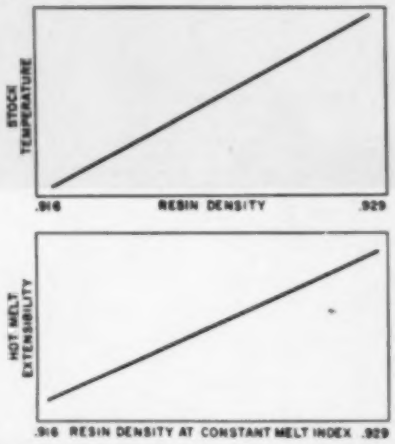
HOW RESIN DENSITY AFFECTS FILM PROPERTIES, EXTRUSION CONDITIONS

Extruders of blown or flat film will find, in working with some of the newer polyethylene resins of about .93 density, that they are significantly different from the more conventional resins of about .92 density — both in behavior during processing and in properties of the final film.

Operating Temperatures and Speeds Rise

As resin density increases from .916 to .930, higher stock temperatures are required — ranging from 10 to 30°F higher, depending on the resin. At the same time, blown film does not have to be cooled as much. Since the higher density resins have a harder surface, are less tacky, and do not block readily, the temperature of a film of .930 density resin can be 10-20°F higher at the nip rolls of the take-up without introducing internal blocking.

The higher film temperatures at the pinch rolls help prevent wind-up wrinkling to which higher density films are susceptible (see U.S.I. Polyethylene Processing Tips, Vol. III, No. 3). Less cooling means faster production using higher density resins, and is also advantageous when space for cooling equipment is limited.



It should be remembered, in processing higher density resins, that the resulting films have lower impact strength than do films from lower density resins. Therefore, excessive roll pressures in blown film wind-up should be avoided, to prevent too sharp a crease in the flattened film cylinder, particularly in gussetted film. A sharp crease, when subjected to impact loading during film use, will frequently fail by tearing.

Also, as density increases from .916 to .930, resins have better hot melt extensibility — can be drawn down to thinner gauges. U.S.I.'s .929 density resin, for example, has been drawn down to less than 0.2 mils thickness in a regular production run.

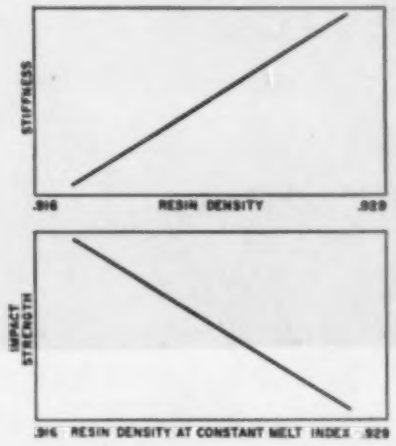
Films are Stiffer, Easier to Handle: Seal Hotter

Films extruded from higher density resins have more body and less stretch than do those made from conventional resins. This means that they are easier to handle on standard converting equipment and can be more easily used on high-speed converting and packaging machinery.

In heat sealing, as in extrusion, slightly higher temperatures must be used to effect a satisfactory seal with the higher density resins.

Clarity Up, Impact Strength Down

At lower densities of about .93, films are clearer, have less haze, higher gloss, greater transparency. They are stiffer, with more tensile strength, but have lower impact tear and impact strengths. Because they have harder surfaces, they are more abrasion-resistant. Heat resistance also increases. Permeability goes down (see U.S.I. Polyethylene Processing Tips, Vol. II, No. 2).



As you can see, the extruder's choice of resin density will depend largely on the film properties desired by his customer. For toughness, flexibility and good protection, low densities are indicated. For more stiffness, clarity and heat resistance, higher densities are coming into prominence.

U.S.I. offers a series of polyethylene resins, ranging in density from .916 to .929. U.S.I. technical service engineers can recommend the proper resin with the best balance of properties for your particular application. They will be glad to work with extruders and converters on processing problems as well.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N.Y.
Branches in principal cities

CAST PETROTHENE® POLYETHYLENE

guide to

PETROTHENE®

polyethylene resins

FILM EXTRUSION——

APPLICATION	GAUGE (mil)	ESSENTIAL PROPERTIES	recommended PETROTHENE RESINS
GARMENT BAGS	0.4 to 0.75	High draw-down, good clarity, high gloss, resistance to blocking, good slip.	207, 239
SOFT-GOODS BAGS	0.75 to 1.25	High draw-down, high clarity, good gloss, resistance to blocking, good slip.	206, 207
PRODUCE BAGS			
SMALL	1 to 1.25	Moderate toughness, clarity, gloss, resistance to blocking, good slip.	205, 210
LARGE	1.5 to 2	Higher toughness, fair clarity, gloss, resistance to blocking, good slip.	200, 205, 210
CHEMICAL PACKAGING BAGS	1.5 to 3	Toughness, resistance to blocking, good slip.	200, 204
CONSTRUCTION AND ARCHITECTURAL	4 to 6	Extreme toughness.	200, 301

FILM EXTRUSION—— *(cast and quenched)*

SOFT-GOODS BAGS	0.4 to 0.75	High draw-down, clarity, gloss, resistance to blocking, good slip.	239
OVERWRAP	0.75 to 2	Clarity, gloss, resistance to blocking, good slip.	239
PRODUCE BAGS	1 to 2	Moderate toughness, clarity, resistance to blocking, good slip.	200, 205, 210
CONSTRUCTION AND ARCHITECTURAL	4 to 6	Extreme toughness.	200, 301
AGRICULTURAL (MULCH)	0.75 to 2	Moderate toughness, high draw-down.	301-218
	2 to 6		102, 102-218
PIPE EXTRUSION		NSF approved for potable water	102-216
		Nonpotable water supplies	550-218
CALENDERING			102, 102-216

PETROTHENE TYPES RECOMMENDED *for different applications*

USE	ESSENTIAL PROPERTIES	recommended PETROTHENE RESINS
PAPER COATING	Good draw-down, freedom from odor, good adhesion, grease proofness, heat sealability	
	Best draw-down	207, 239
	High resistance to permeability	100, 239
	Minimum "neck-in"	100, 200
	Balanced properties	205, 210
WIRE AND CABLE COATING	Excellent dielectric properties	
	Excellent resistance to environmental stress cracking	
	High frequency insulation	300-6
	Wire and cable jackets, where unusual stress crack conditions are encountered	300-200
	Primary insulation for telephone cables, general insulation where color coding is required	300-Color Code
	Good resistance to environmental stress cracking	
	High frequency coaxial cables; primary insulation for telephone cables, multi-conductor control cables, power cables	301-6
	Weather resistant wire and cable; neutral supported secondary and service drop cable	301-200
	WD1/TT infantry field wire	301-202
	Primary insulation for telephone cables; general insulation where color coding is required	301-Color Code
	General-purpose applications	
	Non-critical, non-specification insulation	302-6
	TV antenna lead-in wire	302-506
INJECTION MOLDING	Fast flow, maximum stiffness	
	Size:	
	Very large (>20 oz)	208, 241
	Very large (>20 oz), high resistance to low-temperature brittleness and shattering	202
	Large (10 to 20 oz)	202, 203, 207, 208
	Small (6 to 10 oz)	201, 203, 206, 207, 239
	Very small (<6 oz)	200, 204, 205
	Best transparency and gloss	207, 208, 241
	Best freedom from warp (low level of locked-in stresses)	202
BOTTLE BLOWING	Best appearance	102, 206
	Highest environmental stress cracking resistance	301
THERMOFORMING	Stiffness, chemical resistance, low water absorption	205, 239
	Maximum resistance to sag	239, 301
	High stiffness and thin walls	239
	Optimum toughness and great flexibility	301
	Good balance of end properties	205

FORM: Solid cubes approximately $\frac{1}{8}$" on a side.
COLOR: All PETROTHENE types are available in various colors as well as natural.
PACKAGING: Polyethylene coated multi-wall bags net weight 50 lbs.; 1500 lbs. and 9000 lbs. U. S. Rubber Sealdbins. Palletized shipments upon request.
MINIMUM ORDER: 50 lbs.
TERMS: Net 30 days.
AVAILABILITY: Warehouse stocks are maintained in most major processing areas. Your nearest U. S. I. Sales Office will give you detailed information on delivery dates.
TECHNICAL SERVICE: For technical assistance contact your nearest U. S. I. Sales Office.

U.S.I. INDUSTRIAL CHEMICALS CO.
Division of National Distillers and Chemical Corp.
99 Park Ave., New York 16, N. Y.
Branches in principal cities

TITANOX* to the rescue! Part of the appeal of vinyl-covered furniture lies in its light or pastel finish . . . and part of the appeal of TITANOX titanium dioxide white pigments is how economically they produce properties of whiteness, brightness and opacity in plastic or rubber stocks. Whether your formula calls for TITANOX-RA, TITANOX-RA-50 or TITANOX-RA-NC, you'll find these leading white pigments a pleasure to work with—in uniformity that permits easy regulation of opacity and tint, in the contribution they make to product durability, and in ease of processing. Titanium Pigment Corporation, 111 Broadway, New York 6, N. Y.; offices and warehouses in principal cities.

TITANIUM PIGMENT CORPORATION

Subsidiary of **NATIONAL LEAD COMPANY**

*TITANOX is a registered trademark for the full line of titanium pigments offered by Titanium Pigment Corporation.

5728

What extruding capacity do you need?

Large or small, there's an

NRM *Thermoplastics* EXTRUDER

to meet your requirement exactly...

AN NRM 15" THERMOPLASTICS EXTRUDER GETS FINAL INSPECTION.

AN NRM ENGINEER INSPECTS THE HEAVY-DUTY THRUST AND RADIAL BEARING ASSEMBLY USED IN THE 15" EXTRUDER ABOVE.

Whether you need 50 pounds per hour of plastics production from a single machine or 5,000, you'll find the right type and size extruder in the NRM full line to produce it *economically*. From 1" Laboratory Bench Models to big 15" high capacity extruders with Automatic Die Head Clamps like the model shown, all are standard, and all have the "years-ahead" design and construction features that make NRM Extruders most versatile to use, most profitable to operate, and least expensive to maintain.

Where special applications require extruders of unusual size or design, *standard* proven NRM design features can often be incorporated to obtain a "custom" extrusion installation, at less than "custom" cost to the customer. Contact us for assistance in selecting the right type and size NRM Plastics Extruder for *your* work. There's no obligation.

Write for the NRM full line brochure TODAY!

2869

NATIONAL RUBBER MACHINERY COMPANY

NRM

Creative Engineering

General Offices and Engineering Laboratories: 47 West Exchange St., Akron 8, Ohio
EASTERN PLANT: 384 Getty Ave., Clifton, N. J.
SOUTH: The Robertson Company, Rutland Building, Decatur, Ga.
WEST: S. M. Kipp, Box 441, Pasadena 18, Cal.
MID-WEST: National Rubber Machinery Company, 5875 N. Lincoln Ave., Chicago 45, Ill.
CANADIAN: F. F. Barber Machinery, Ltd., 187 Fleet St., West, Toronto, Ont.
EXPORT: Omni Products Corporation, 460 Fourth Ave., New York, N. Y.

PLASTICS TECHNOLOGY

SEPTEMBER, 1958

EDITORIAL:

Extrusion Machine Issue

In this issue, we are proud and pleased to present the second installment — Extrusion Machines—of our special feature series covering the various classes of plastics processing machines. The first installment, dealing with Injection Molding Machines, was published in our May issue and brought wide acclaim.

Following the system established for injection machines, the extrusion machine section consists of two parts; a specially-written article by R. E. Monica, extrusion specialist for Dow Chemical's Plastics Technical Service, and a lengthy, staff-written tabulation of comparative specification data on the 1958 extrusion machines available from domestic manufacturers of plastics extruders.

•

While proud of this tabulation, we realize that it represents only a major step forward towards the goal of machinery standardization that is so badly needed before the plastics industry can achieve true maturity.

At present, a plastics engineer planning to buy a new extrusion machine (to name only one type of plastics processing machine) goes through the following routine: Upon contacting the extruder manufacturers, he is deluged by a flood of literature, and even visits from their representatives, extolling the unique advantages of each machine. Since he has no logical basis for choice, his final decision on the machine he will buy is based on opinions received from other processing firms and the residual effects left with him by the extruder manufacturer's promotions. This is hardly a logical method for selection!

As is evident, our tabulation comprises 28 machinery classifications for extruders. Good as it is, we know that it is only a noted step towards standardization. The extruder manufacturers, themselves, are trying to standardize, and we can promise you an even better and more complete tabulation when we next deal with extrusion machines!

•

Forthcoming in a few months will be the next machinery installment—on compression and transfer presses. Finally, when this series is completed, a repetitive series will be started immediately to cover the various machinery types on either a one- or two-year cycle that will be as up-to-date as possible. We're on our way to help the plastics processors.

Exposition Issue Next Month

The October issue will contain a Special Feature Section previewing the forthcoming Eighth National Plastics Exposition, to be held in Chicago's International Amphitheatre on November 17-21, 1958. Look for it to make your plans to visit the show more rewarding!

Arthur M. Merrill

Editor

VACUUM FORM IN A BIG WAY with HI-FAX®

Now it is possible to combine the economy of vacuum forming with the outstanding properties of Hi-fax high-density polyethylene. These commercially available tote boxes are a good example of how Hi-fax is helping to make good products even better. Rigid, strong, lightweight, resistant to heat and chemicals, the boxes were produced on a fully automatic rotary vacuum forming press.

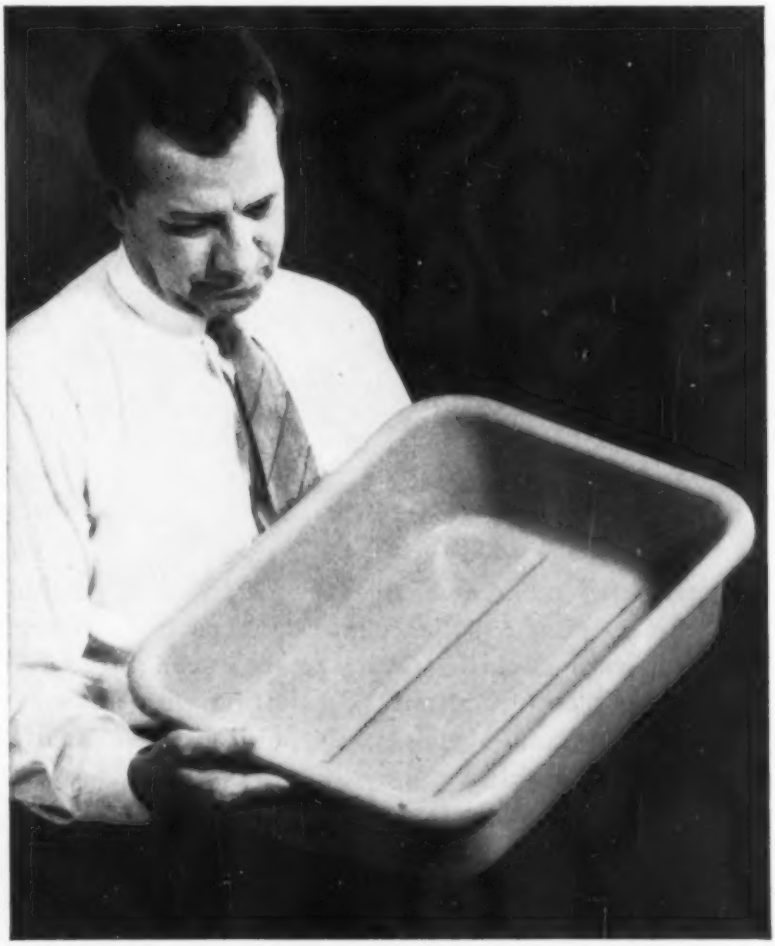
For superior stress crack resistance and toughness more and more manufacturers are turning to extruded sheet based on Hi-fax—the plastic that's different! Perhaps Hi-fax extrusions can provide the solution to your own processing needs. For further technical information, write:

Cellulose Products Department

HERCULES POWDER COMPANY

900 Market Street, Wilmington 99, Delaware

CPSS-7



SMOOTH, GLOSSY SURFACE is one of the features of these tote boxes. They are commercially available in two sizes.

RIGID STRENGTH is a "built-in" feature with Hi-fax. Tote box was vacuum formed by **Jewel City Products,** Los Angeles, with sheet extruded by **Jet Specialties Co.,** Los Angeles.

CHEMICAL RESISTANCE to food greases, oils and other corrosive materials makes Hi-fax ideal for products that must withstand unusual conditions.

Uniform Color Batch to Batch

"Off" colors, from one batch to the next, can be costly in many ways . . . in the time and cost of compounding and re-compounding . . . in rejects and returns, in lost good will and in damaged reputation.

adp quality dispersions make quality products.

adp dispersed colors are uniform between batches . . . each re-order a precise duplicate of the specified standard.

adp dispersed colors, with reasonable compounding, give uniform extensibility without streaking. Pigments extend further . . . color development is better . . . and you save time and money.

adp dispersed colors have advantages of uniformity unmatched in dispersions made by ordinary methods.

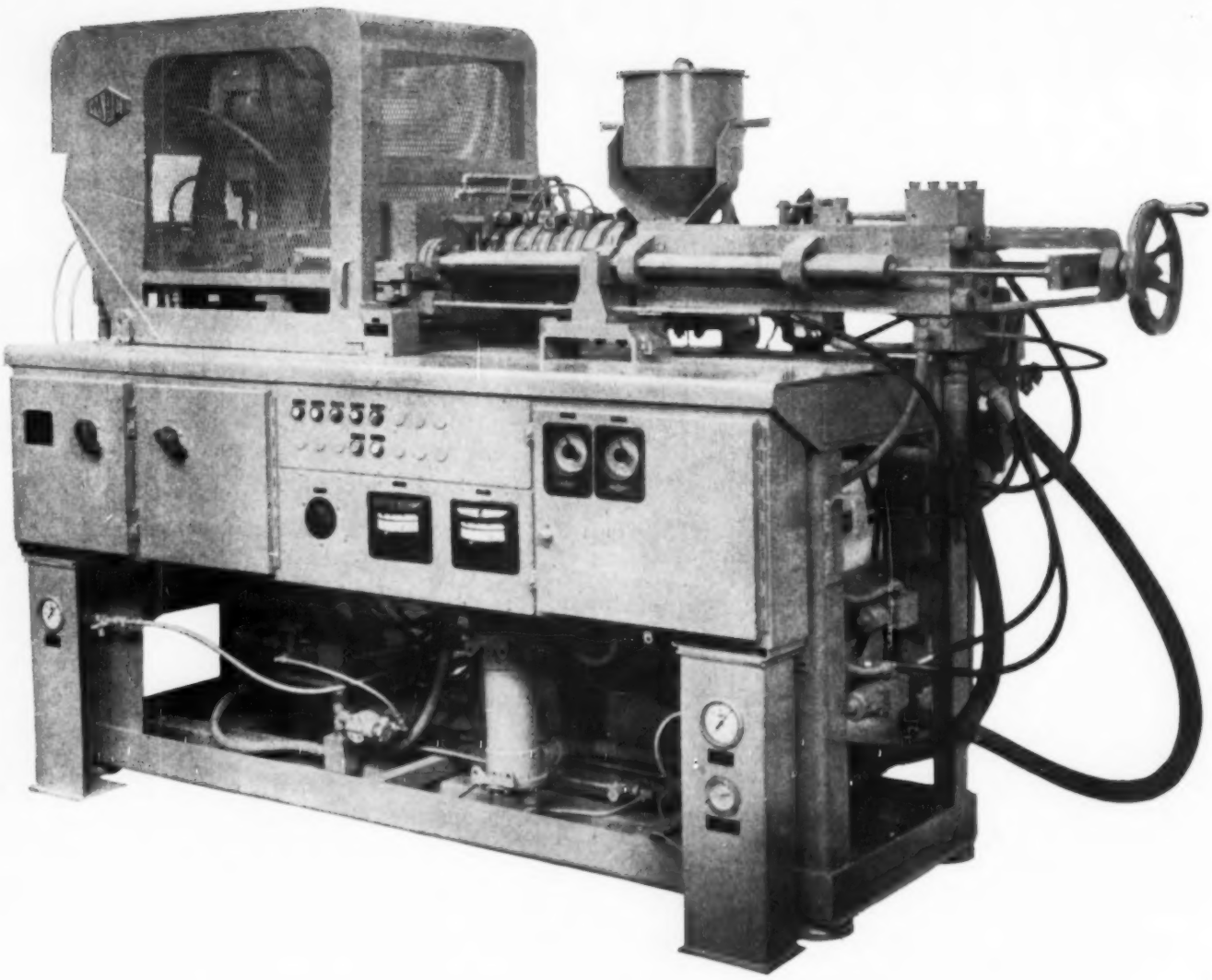
adp dispersions cannot be matched for economy.

adp specialists will be glad to help you with *your* dispersion problems.

CONTROLLED COLORS BY adp

ACHESON Dispersed Pigments Company
1421 Chestnut Street, Philadelphia 2, Pa.

A Unit of Acheson Industries, Inc. Plants at Orange, Tex., Philadelphia, Pa., Xenia, O.
West Coast Distributor: B. E. Dougherty Company, Los Angeles 21, California
In Europe: Acheson Industries (Europe), Ltd., 18 Pall Mall, London S.W. 1, England



ANOTHER NEW IMPCO

Special Purpose Injection Molding Machine for Containerlike Molding

MODEL CA30-75

- 30-50 gram capacity
- 30 molding cycles per minute*
- shut-off nozzle for pre-pressurized molding
- simplified mold construction
- built-in die and platen cooling arrangement
- separate injection and clamp hydraulic circuits
- shock mounted control panel
- photo electric recycling monitor
- 75 ton clamp
- 9¼" stroke
- fully automatic

*dependent on material and mold construction

IMPCO IMPROVED MACHINERY INC.

NASHUA · NEW HAMPSHIRE

In Canada, Sherbrooke Machineries Limited, Sherbrooke, Quebec

NEWS in BRIEF

All-vinyl molded footwear may be the trend in casual wear. Injection-molded, one-piece loafers and sandals were introduced in France four years ago, and have spread to other countries. Starting this December, the newly-formed national headquarters, Utrilon Corp., expects to produce two million pairs of shoes annually in the United States.

The F-105 Thunderchief, the Air Force's supersonic fight-bomber, employs more than 20 tons of pebbles to fortify the epoxy plastic molds used to shape the plane's vital parts. These molds were made more cheaply and quicker than the previously-used steel, aluminum, and kirksite tools.

Research is the key to the plastics crisis, according to A. E. Gabriel, research project leader for Evans Research & Development Corp. (see Guest Editorial, page 815). Properly performed, research produces amazing results, as proved by past experience. Research may develop new products and processes, and open up new ideas and avenues of thought.

Company expansions in plastics showed the hoped for pick-up after the summer slack-off. Plans to build an organic chemicals plant at Owensboro, Ky., were announced by W. R. Grace's Dewey & Almy division. Morningstar-Paisley will set up large-scale processing equipment for latices and plastisols at its Clifton, N. J. plant. Plastics Mfg. has moved into its new plant and offices in Dallas, Tex. Commercial production of epoxy resins has begun at Reichhold Chemicals' new plant in Ballardvale, Miss. Resistoflex plans the third expansion to its main plant at Roseland, N. J. A new warehouse and office building is being erected by Sommers Plastic Products in East Rutherford, N. J. Wilson & Geo. Meyer opened new offices and warehouse facilities in Los Angeles, Calif.

Business developments in the plastics industry were varied in nature. Successor to five Canadian companies is Allied Chemical Canada, a newly formed corporation. Carlon Products acquired Plastic Industrial Products Co. and will operate it under the former's custom extrusion dept. Enjay Co. has entered the plastics field to make polypropylene and also supply the plastic material to Spencer Chemical. Food Machinery & Chemical formed two new departments to handle inorganic and organic chemicals, respectively. National Research Corp. signed a five-year cross-licensing agreement with Leybold-Hachvakuum-Anlagen, a German firm, to cover four specific areas of applied high-vacuum engineering. Nopco Chemical and its subsidiary, Metasap Chemical, moved into new headquarters in Newark, N. J. Pantasote has been licensed by an Italian firm to make the latter's vacuum-formed vinyl shipping trays for soft fruits. Philip Morris, the cigarette company, entered the plastics field by purchasing Polymer Industries, Inc., producer of industrial adhesives, textile chemicals and intermediates. Tube Turns Plastics and Swepco Tube have formed a joint project whereby the latter will make unplasticized PVC pipe and the former will make the fittings. Wasco Chemical purchased Celastic Corp., maker of acrylic sheet and other plastic materials.

New Materials of special interest: (see pages 853-4) four new epoxy casting resins; electrical-grade plasticizer for plastisols; two stabilizers for vinyl plastisols; two epoxy resin casting systems; and organophosphorous modifier for liquid epoxy resin systems.

New Equipment to be noted (see pages 855-6): carousel-type-extruder-injection molder combination; heat-sealing table with high-frequency generator and sealing electrode; die cutting press; motorized die handler; and a semi-automatic transfer molding press.

Plastics Applications of special interest (see pages 858-9): imitation stone facing of glass-reinforced polyester; wood folding door or room divider having nylon-reinforced vinyl taping; disposable polyethylene syringes; patterned light-diffusing panels of extruded styrene and acrylic; non-conducting glass-reinforced polyester ladders; and home bowling set of polyethylene.

THE MARK OF QUALITY

BARBER COLMAN

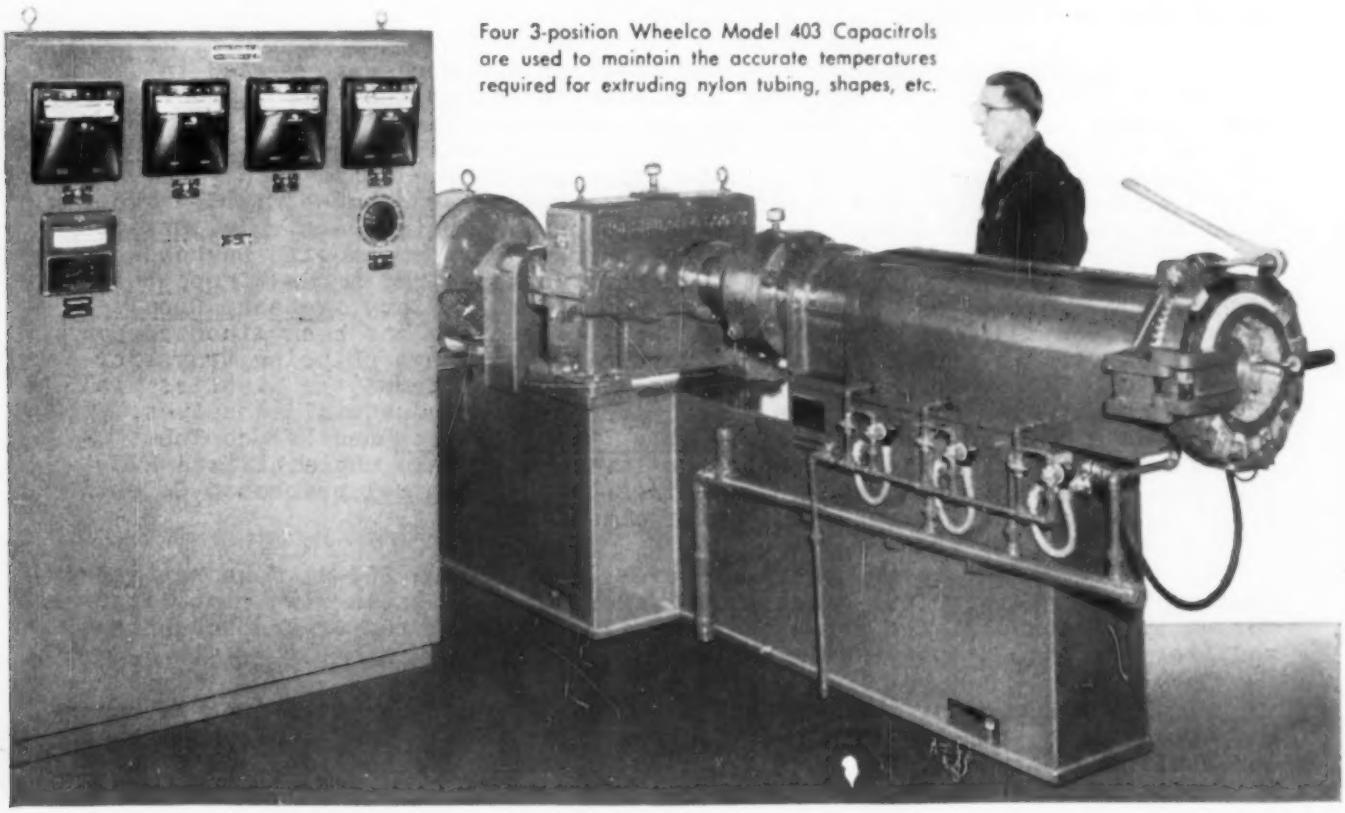
Wheelco Instruments

Automatic, multi-zone temperature control insures high-quality nylon extrusions

This induction-heated Aetna-Standard extruder with a Kullgren Temperature Control System always provides exactly the right temperature for extruding nylon tubing, shapes, etc. Three zones of automatic heating, plus provisions for cooling in the alloy steel barrel of the cylinder extension and a separate heat zone in the high-pressure head, insure precision control. Warmup from room temperature to 400° F takes less than 30 minutes, to 600° F takes less than an hour.

Wheelco Model 403 multi-position type controllers are ideal for this application because they were specifically designed for processes where one instrument is required to control both heating and cooling cycles.

Wheelco 400 Series Capacitrols offer you a choice of six control forms, so why take a chance on sacrificing product quality or operating efficiency by using an indicating controller that doesn't quite do the job? Bulletin F-6314-3 gives you the facts. Write for it today or get it from your nearby Wheelco field engineer. Learn for yourself why Wheelco continues to lead in plastics industry control applications.

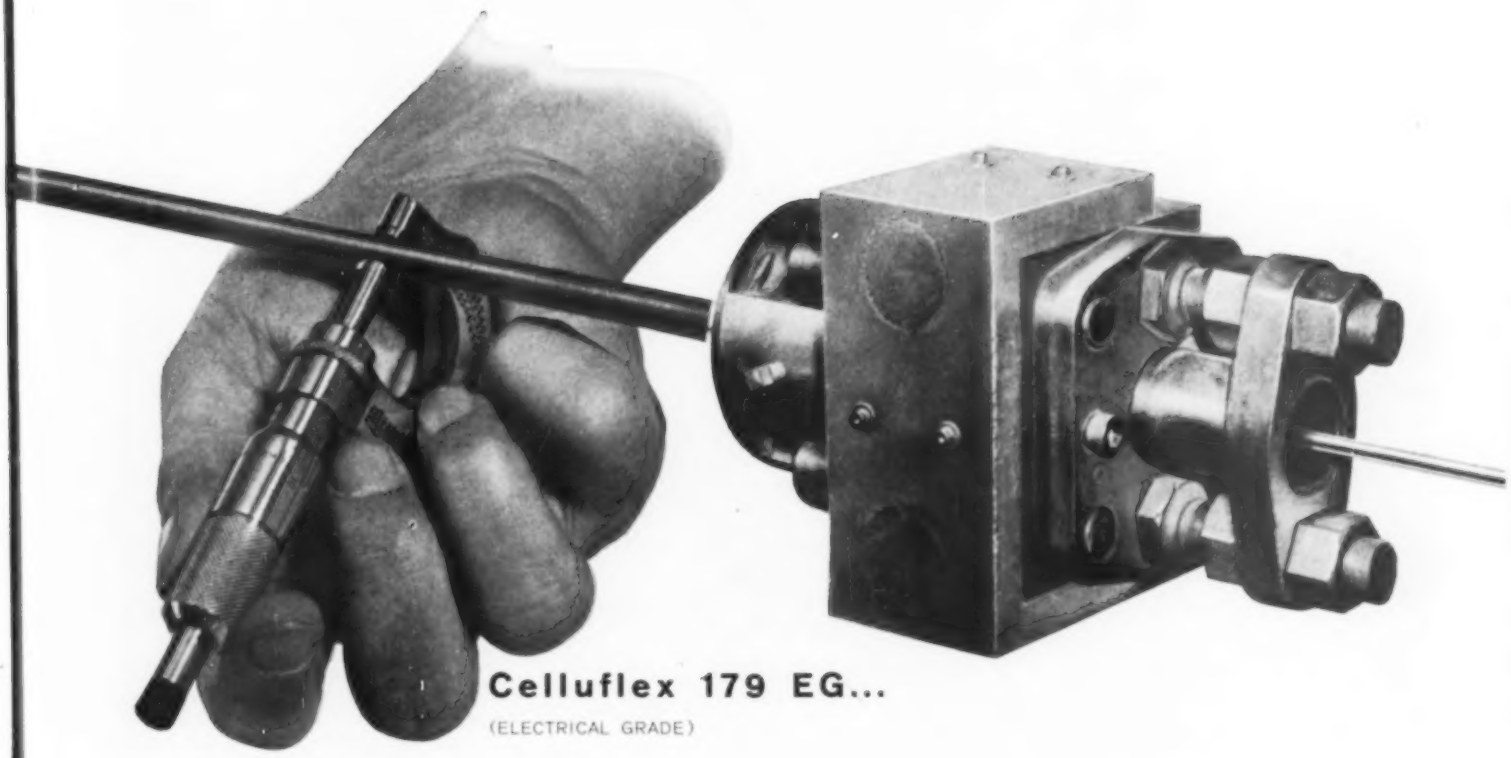


Four 3-position Wheelco Model 403 Capacitrols are used to maintain the accurate temperatures required for extruding nylon tubing, shapes, etc.

BARBER-COLMAN COMPANY

Dept. I, 1565 Rock Street, Rockford, Illinois, U.S.A.

BARBER-COLMAN of CANADA, Ltd., Dept. H, Toronto



Celluflex 179 EG...

(ELECTRICAL GRADE)

selected for dependability and ease of processing

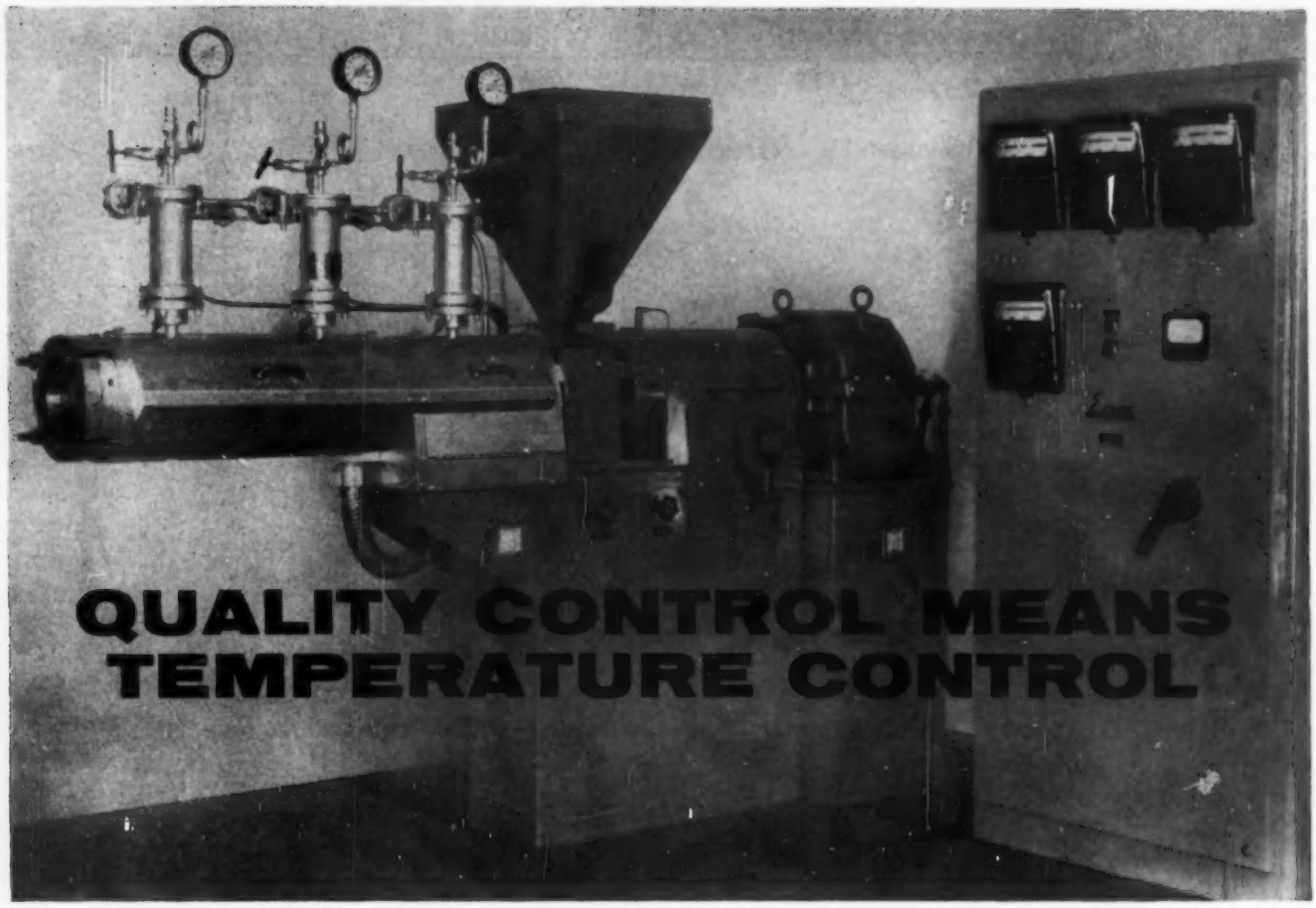
. . . add excellent volume resistivity, low volatility, fire resistance, excellent solvating action, oil and water resistance . . . result: a tricresyl phosphate specially developed for the wire and cable industry for application in vinyl coverings.

Celanese is an expanding source for plasticizers for many jobs. Shipments from convenient distribution points are ready to meet tight schedules.
Write Celanese Corporation of America, Dept. 546-S, Chemical Division, 180 Madison Avenue, New York 16, N. Y., for complete information.
Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Avenue, New York 16, N. Y.

Celanese® Celluflex® Lindol®

Celluflex 179 EG . . . a Celanese CHEMICALS plasticizer

Call Celanese for: Tris-beta Chlorethyl Phosphate . . . *CELLUFLEX CEF*; Epoxy Plasticizers . . . *CELLUFLEX 21 and 23*; Four grades of flame-retardant Tricresyl Phosphate . . . *LINDOL (low color)* . . . *CELLUFLEX 179A (low specific gravity)* . . . *CELLUFLEX 179C (general purpose grade)* . . . *CELLUFLEX 179EG (electrical grade)*; Cresyl Diphenyl Phosphate . . . *CELLUFLEX 112*; Dibutyl Phthalate . . . *CELLUFLEX DBP*; Dioctyl Phthalate . . . *CELLUFLEX DOP*; Triphenyl Phosphate . . . *CELLUFLEX TPP*.



Egan Extruder With "Willert Temperature Control System" Automatically Eliminates Temperature Variations

Heating the plastic material in the extruder cylinder, whether by conduction, induction, or friction, is no problem — assuming the designer has provided sufficient heating capacity and a properly designed screw.

However, provision for efficient dissipation of excessive heat is essential to make any temperature control system complete.

The Willert System is the ultimate in complete control! Excessive heat is removed automatically without moving parts, and without any manual operation of valves or switches by the operator. As a result, closer tolerance extrusions are produced easier and faster.

The Egan Extruder shown above, complete with "Willert Temperature Control System," is available in sizes from 2" through 10". It incorporates standard Egan features such as: herringbone gears, separate heavy duty thrust bearing assembly, complete control panel, wiring, piping, hinged covers for easy access to thermocouples, hopper, screw speed tachometer, and ammeter. Additional features are available.

Write, or Phone Randolph 2-0200,
For Complete Information — No Obligation.

Egan **FRANK W. EGAN & COMPANY**

SOMERVILLE, NEW JERSEY
CABLE ADDRESS: EGANCO — SOMERVILLE (NJER)

Manufacturers of plastics extruders, dies, take-offs, and other accessories

REPRESENTATIVES: MEXICO, D. F.-M. H. GOTTFRIED, AVENIDA 16 DE SEPTIEMBRE; JAPAN-CHUGAI BOYEKI CO., TOKYO.
LICENSEE: GREAT BRITAIN-BONE BROS. LTD., WEMBLEY, MIDDLESEX.

"HIGH QUALITY EPOXY TOOLING AT LOW COST"

AVCO *Speeds ICBM Nose Cone Development With Unique Checking Tools Made of*

RCI Epoxy Resins and Polyurethane Foam

"In producing experimental missile components, we need a fast, foolproof and economical method of checking accuracy. And Reichhold EPOTUF epoxy resins have played a major role in our development of just such checking units."

Speaking is Mr. Bob Thompson, Plastics Project Leader, Experimental Manufacturing Department, AVCO Research and Advanced Development Division, Lawrence, Massachusetts.

AVCO's experimental work on the Titan ICBM nose cone is a vital, high priority project. Complex parts must meet exact tolerances. The slightest imperfection might cause failure.

For instance, one length of pipe for the nose cone twists and turns sixteen different times in its 34-inch length. To test the accuracy of each bend, AVCO has developed tools such as you see above made of RCI epoxy resins and RCI polyurethane foam. Such devices can be made quickly and inexpensively, and solve one of AVCO's toughest testing jobs.

"Furthermore, another benefit we gain in dealing with RCI is invaluable technical aid," Mr. Thompson stated. "Also we have never experienced any delays in delivery . . . and we absolutely need this kind of service."

Perhaps dependable, versatile RCI EPOTUF epoxy resins or RCI POLYTOOL plastic tooling compounds will improve *your* application. Write RCI for details.

REICHHOLD

Synthetic Resins • Chemical Colors • Industrial Adhesives • Phenol
Hydrochloric Acid • Formaldehyde • Glycerine • Phthalic Anhydride
Maleic Anhydride • Sebacic Acid • Ortho-Phenylphenol • Sodium Sulfite
Pentaerythritol • Pentachlorophenol • Sodium Pentachlorophenate
Sulfuric Acid • Methanol

Creative Chemistry . . .
Your Partner in Progress

REICHHOLD CHEMICALS, INC., RCI BUILDING, WHITE PLAINS, N.Y.

AMOCO CHEMICALS—A NEW RESOURCE

PANAFLEX BN-1 can untie knotty vinyl extrusion cost problems

Are you making vinyl extrusions for low-cost applications—welting, tubing, hose—for either permanent or expendable uses? Perhaps PANAFLEX BN-1 can help you with your raw material cost problems.

PANAFLEX BN-1 is a hydrocarbon secondary plasticizer for vinyls. It is a clear, light straw-colored liquid, compatible with vinyl chloride polymers and copolymers. It formulates readily with primary plasticizers, pigments, stabilizers and other ingredients. Color stability and volatility compare favorably with other hydrocarbon-type plasticizers. Its specific gravity is only 0.946.

In large-volume compounding for extrusions, a few cents saved per pound of compound makes a big difference in profits. PANAFLEX BN-1 can help you widen your margin of profit by reducing your compound costs. You'll get a good-quality finished product plus, in some instances, improved processing.

Your request for further information will receive immediate attention.

AMOCO CHEMICALS

AMOCO CHEMICALS CORPORATION
910 South Michigan Ave., Chicago 80, Illinois

More Than 100 Years Of Know-How

of the Engineering Staff at Modern Plastic Machinery Corporation are represented in the new "CENTURY SERIES" of Extruders available in screw sizes from 1" to 8" diameter

BEFORE YOU BUY ANY EXTRUDER... *Compare* mpm

At modest cost you receive:

- Air-cooled cylinders.
- Xaloy 306 liners in all sizes—1" to 8"
- High speed, high horsepower, high pressure (10,000 psi working pressure).
- High-thrust bearing capacity.
- Long bearing life.
- True bearing ratings.
- Over-size herringbone gear transmissions in 2½"- 8" sizes.
- 16:1—20:1—24:1 Length/Diameter ratio cylinders (measured from front of feed opening). (Special lengths on request.)
- Vented cylinders, hoppers or screws.
- Interchangeable band heaters, cast-in heaters, induction heaters.
- Easily replaced cylinders.
- Complete packages fully wired for low cost installation.

A full line of valves, pressure gauges, dies and other accessories are available.

MPM BENCH EXTRUDER MODEL EF-100-12

(This extruder available in pedestal mount for striping — Model ESF-100-12)

MPM Extruders are available in screw sizes of 1" — 1½-2" — 2½" — 3½" — 4½" — 6" — 8" with cylinders of 13.1 — 16:1 — 20:1 — 24:1 — LE/D Ratio — with or without vents

MPM Model No.	ESF-100-12 EF-100-12	EF-250-20	EF-350-20
Screw Diameter	1"	2½"	3½"
Le/D Ratio	12:1	20:1	20:1
Heating Load—Watts	1800	12,750	25,000
Heating Zones	2	4	4
Gear Ratio (Standard)	20:1	23.8:1	24.9:1
Transmission HP at 75 RPM	.45	28	37
Type Gears	Worm	Herringbone	Herringbone
Thrust Bearing Capacity Dynamic Load Rating	11,750#	215,000#	400,000#
B-10 Life at 75 rpm	4,000 hrs. at 5,000 psi 32,000 hrs. at 2,500 psi	27,000 hrs. at 10,000 psi 216,000 hrs. at 5,000 psi	25,200 hrs. at 10,000 psi 201,600 hrs. at 5,000 psi
Motor HP	.5	15 - 25	25 - 30
Screw Speed (Standard)	8-80 rpm	7-85 rpm	7-85 rpm
Output per hour	6-12 lbs.	85-135 lbs.	200-250 lbs.
Cooling System—Cylinder	None	Air	Air
Cooling System—Hopper	Water	Water	Water

Note: B-10 Life — See Anti-Friction Bearing Mfg. Assoc. Stds. Specifications for other size Extruders on request.

100% COMPLETE PACKAGED UNITS WITH ALL ACCESSORIES

VISIT BOOTH No. 645 SPI Convention, Chicago, and see for yourself!

modern plastic machinery corp.

15 Union St., Lodi, N. J., U. S. A. • Cable Address: MODPLASEX

IN USE IN THE UNITED STATES AND THROUGHOUT THE WORLD

NEW 2 RIGID For pipe

These rigid vinyl compounds just announced by Bakelite Company *outperform any other rigid vinyl on the market today!* Greater resistance to chemicals—better heat stability—*as much as 100% faster extrudability, with better surface smoothness*—all these, and other advantages are offered by both materials.

QGD-5020, a modified Type II rigid vinyl, offers a new, high impact strength, making it *one of the toughest plastic materials commercially available.*

Both materials are exceptionally free-flowing. QGD-5010, with outstanding chemical inertness, will find widest application in commercial and industrial corrosion-resistant pipe.

In addition to standard pipe applications, the QGD-5020 compound is a superior general purpose extrusion material for contour applications such as channels and framing members for windows and storm sash, electrical conduits, down spouts and gutters, fountain pen and automatic pencil barrels, and many more!

★ ★ ★

Complete details on both compounds are given in new technical bulletins. Write today to Dept. UQ-32H.

VINYL COMPOUNDS

and all-purpose extrusion

Extrudability!

TYPICAL PROPERTIES	QGD 5010	QGD 5020
Specific Gravity	1.38	1.313
Heat Distortion, deg. C.	70	69
Izod Impact	.6	24 - 30
Rockwell "R"	115	107
Tensile Strength, psi	8500	6500
Elongation, %	50	30
Flexural Strength, psi	11,800	10,000
Flexural Modulus, psi	450,000	357,000
Chemical Resistance, 30 day immersion test		
in H_2SO_4, % change in flex. str.	+ 9.94	+ 3.8
in H_2SO_4, % change in wt.	+ .08	+ .452
in Glacial Acetic Acid, % change in flex. str.	— 42.7	— 68.
in Glacial Acetic Acid, % change in wt.	+ 7.41	+ 17.8

BAKELITE
BRAND
RIGID VINYLS

Products of UNION CARBIDE *Corporation*

BAKELITE COMPANY, *Division of Union Carbide Corporation,* 30 East 42nd Street, New York 17, N. Y.
In Canada, Bakelite Company, Division of Union Carbide Canada Limited, Toronto 7

2033

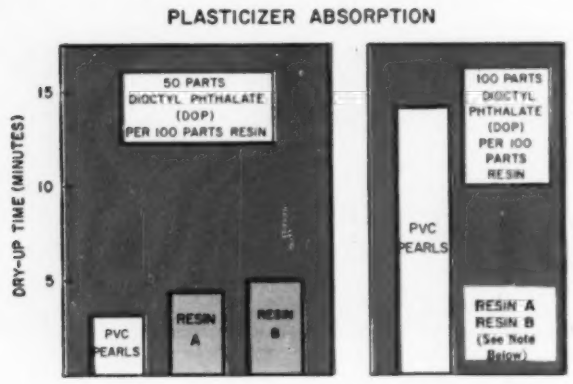
The terms BAKELITE and UNION CARBIDE are registered trademarks of UCC.

We See Escambia PVC Pearls*

As your best investment for easy processing. . . your best remedy for production headaches. . . . your strongest partner in turning out top-quality products because they offer these money-making benefits to you:

- Complete freedom from fines
- Unusually high plasticizer absorption capacity
- Uniform and free-flowing dry blends
- Outstanding heat stability
- Extremely low gel count
- Excellent color and clarity
- Fast extrusion rates

HOW DO THEY LOOK TO YOU?



†Conventional resins A and B could not absorb 100 parts of plasticizer and make a dry blend.

SEE FOR YOURSELF what Escambia PVC Pearls will do for your profit picture —write or call:

ESCAMBIA CHEMICAL CORPORATION

261 MADISON AVENUE • NEW YORK 16, N. Y.

NEW YORK TELEPHONE • OXFORD 7-4315

MANUFACTURERS OF: ESCAMBIA P V C PEARLS*/ ESCAMBIA PVC RESINS / BAY-SOL* (NITROGEN SOLUTIONS) / AMMO-NITE* (PRILLED AMMONIUM NITRATE FERTILIZER)/ANHYDROUS AMMONIA/AMMONIA / NITRIC ACID/METHANOL

*TRADEMARKS OF ESCAMBIA CHEMICAL CORPORATION

PIGMENTS

Profits go up when colors in your plastic products are bright, clean and uniform. For better-looking, faster-selling products, specify Glidden Zopaque titanium dioxide – the whitest white pigment obtainable – plus non-fading, non-bleeding Cadmolith and Mercadmolith colors.

QUALITY Glidden PRODUCTS

FINEST PIGMENTS FOR INDUSTRY

The Glidden Company

Chemicals—Pigments—Metals Division

Baltimore 26, Maryland

We learned a lesson from a lineman

"*Safety* is where I shine," one of our linemen told us recently. "Safety's one of the most important parts of my job. But *saving*—and that's important, too, for a family man—that's too tough. Why don't you guys in the office make it easy for us—like that Payroll Savings Plan for U.S. Savings Bonds?"

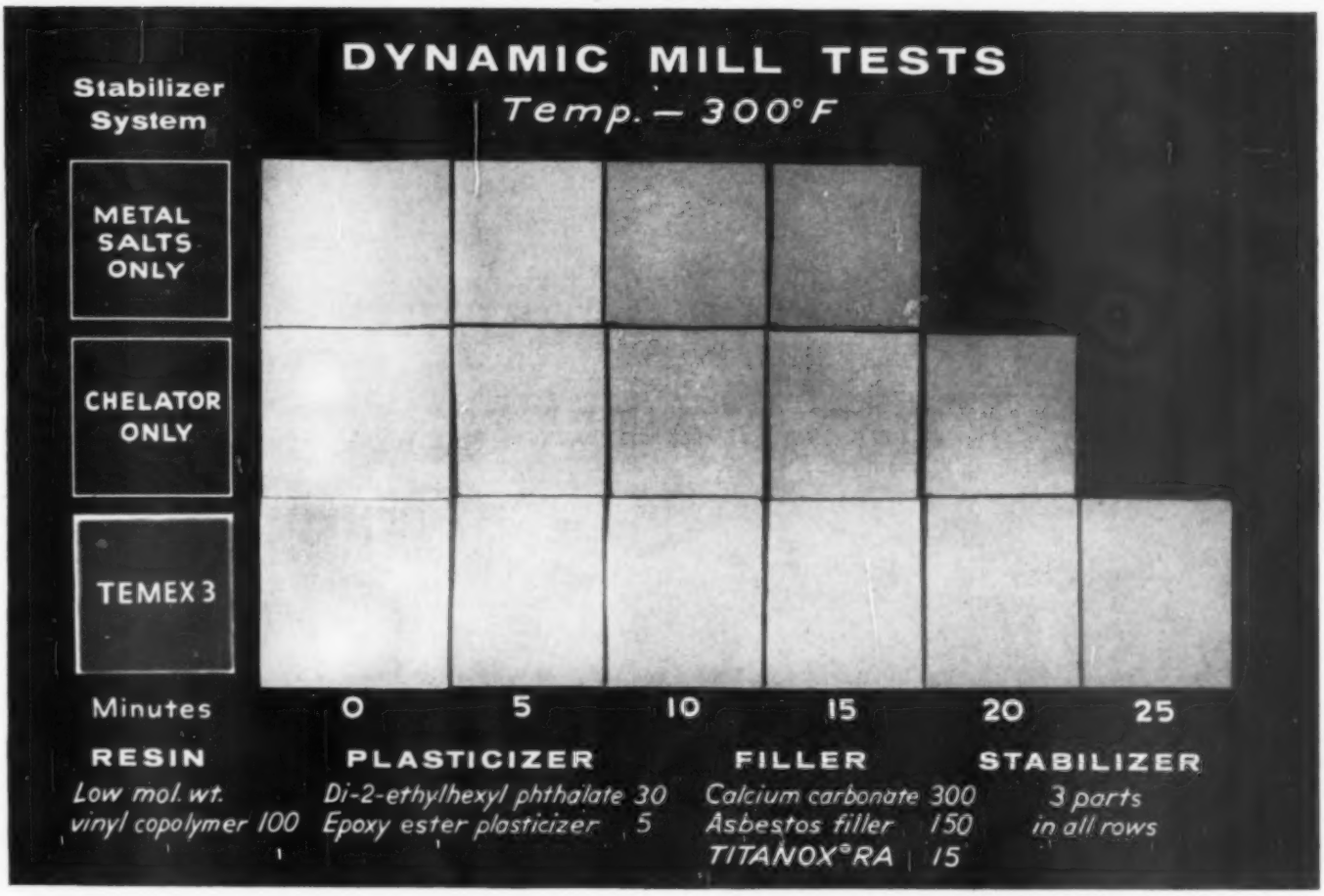
Of course, that is *exactly* what we want to do for *every one* of our people. We explained that to our lineman. But he certainly made us stop and think. Because if *he* didn't know about our plan for buying U.S. Savings Bonds through Payroll Savings, then many other employees must be in the same position.

We telephoned our State Savings Bond Director for help. He worked out a company-wide campaign for us. Application cards were placed in the hands of every person on our payroll. We had a *fair* participation when the campaign started. But within days afterward, we had an *excellent* percentage of bond buying employees.

It shows that practical people welcome a chance to set up this sound savings plan. Today, particularly, there are more payroll savers than ever before in peacetime. Look up *your* State Director in the phone book or write: Savings Bonds Division, U.S. Treasury Dept., Washington, D. C.

PLASTICS TECHNOLOGY

THE U. S. GOVERNMENT DOES NOT PAY FOR THIS ADVERTISEMENT. THE TREASURY DEPARTMENT THANKS, FOR THEIR PATRIOTISM, THE ADVERTISING COUNCIL AND THE DONOR ABOVE



National Lead Company Research Laboratories Test #5145

Proof:

Double-acting "Dutch Boy" Temex 3 does most for color control in vinyl flooring

. . . opens way to brighter and longer lasting hues as well

What a difference in color retention between the three asbestos-filled flooring stocks pictured above!

With "Dutch Boy" Temex* 3 stabilizer, initial color is retained 25 minutes or more. That's because Temex 3 has a unique double action . . . provides improved metal salt stabilization *plus* excellent chelation.

Double action boosts color control in three other important ways

In addition to greatly improved color retention, Temex 3 stabilizer provides three other significant controls over color.

Improves tint development. With lighter base stocks, tints develop brighter and truer hues. Critical color values are easier to obtain.

Broadens the list of usable tints. The low reactivity of Temex 3 stabilizer does away with pinking, bluing and other undesirable color shifts. You are free to use both lighter and stronger tints.

Prevents color degradation from reworked trim. As the test above shows, even extended heat histories do not darken Temex 3 stocks.

Double action lengthens color life, too

Once flooring is laid, "Dutch Boy" Temex 3 stabilizer continues to preserve beauty of flooring. It protects against attack of ultraviolet light. Stabilizer staining by sulfides is eliminated. Its protective action continues through long-term washing and wear.

National Lead research has developed 20 other outstanding stabilizers for various types of vinyl stock. Among them, two more that are widely used in asbestos flooring stock . . . "Dutch Boy" Tribase and Normasal stabilizers . . . and one for non-asbestos flooring . . . "Dutch Boy" Clarite® A stabilizer.

Each of these versatile "Dutch Boy" stabilizers simplifies processing and extends the life of specific vinyl products. Get the details in the latest "Dutch Boy" literature.

*Trademark

Dutch Boy® CHEMICALS

NATIONAL LEAD COMPANY
111 Broadway, New York 6, N. Y.
In Canada: CANADIAN TITANIUM PIGMENTS LIMITED
630 Dorchester Street West, Montreal

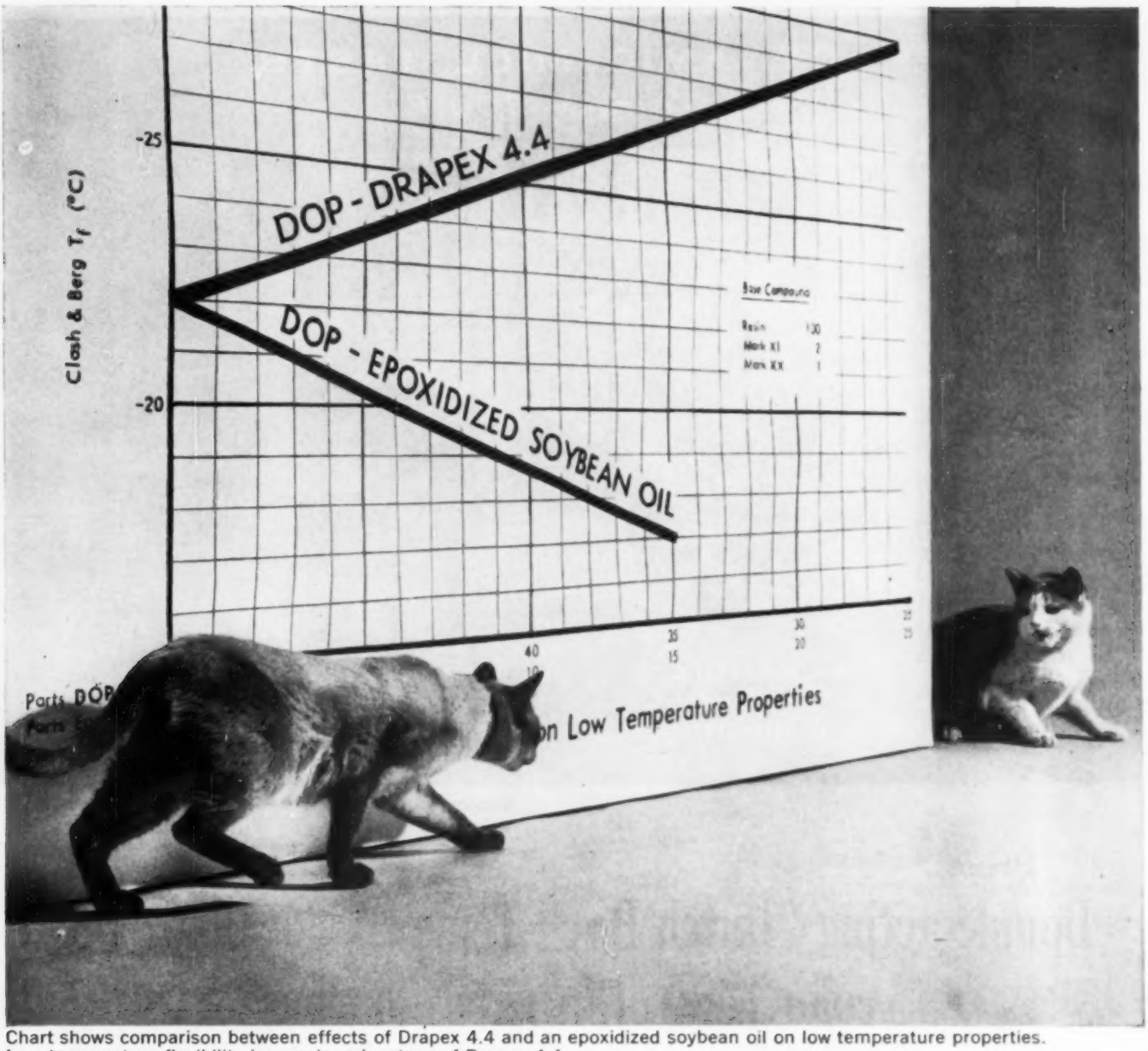


Chart shows comparison between effects of Drapex 4.4 and an epoxidized soybean oil on low temperature properties. Low temperature flexibility is a major advantage of Drapex 4.4.

PURE-BRED EPOXY... AT AN ALLEY-CAT PRICE!

There's a blue-ribbon champion in epoxy plasticizers — Argus' Drapex 4.4! At its new, reduced price, you can replace ordinary epoxy plasticizers with Drapex 4.4 in your vinyl formulations, with the following important advantages:

1. **Low temperature flexibility (see chart above).**
2. **Low volatility.**
3. **Improved heat and light stability.**
4. **Low viscosity and viscosity stability in plastisols.**
5. **Ease of handling (due to low viscosity and low freezing point).**
6. **Good weatherability.**

Argus research has steadily widened the applications of Drapex 4.4 until it now actually costs *less* than other quality epoxies. Moreover, the lower specific gravity of Drapex 4.4 makes it go farther, so that in volume use it costs less than the cheapest competitive epoxy.

For complete information on Drapex 4.4 (and its sister product, Drapex 3.2), write for Technical Bulletin #3.

ARGUS CHEMICAL CORPORATION / New York and Cleveland

Main Office: 633 Court Street, Brooklyn 31, N. Y. Branch: Frederick Building, Cleveland 15, Ohio

Rep's.: H. M. Royal, Inc., 4814 Loma Vista Ave., Los Angeles; Philipp Bros. Chemicals, Inc., 10 High St., Boston; H. L. Blachford, Ltd., 977 Aqueduct St., Montreal.

Western Electric Uses Forticel

CELANESE CELLULOSE PROPIONATE MOLDING MATERIAL

Color has turned the practical telephone into an eye-appealing home and office appliance.

And Forticel, the versatile Celanese plastic, has helped to make the trend to telephone colors practical.

Forticel provides the technically vital properties that are demanded in such a precision instrument as the telephone: shatter resistant toughness . . . good dimensional stability . . . and excellent surface lustre. Production-wise, Forticel offers superb molding characteristics including short cycles, virtually invisible weld lines, good flow around metal cores and inserts, and non-critical flow temperatures.

What can Forticel do for your product? The coupon below can bring you the answer. Celanese Corporation of America, Plastics Division, Dept. 184-S, 744 Broad Street, Newark 2, N. J.

Canadian Affiliates: Canadian Chemical Co., Limited, Montreal, Toronto, Vancouver.
Export Sales: Amcel Co., Inc., and Pan Amcel Co., Inc., 180 Madison Ave., N. Y. 16.

Celanese ® Forticel ®

Forticel . . . a Celanese molding material

TYPICAL PHYSICAL PROPERTIES OF FORTICEL

Flow temperature: (°C.) (A.S.T.M.)	D569-48	145–183
Specific gravity	D176-42T	1.18–1.21
Tensile properties:		
Break (p.s.i.)	D638-52T	1900–5900
Elongation (%)	D638-52T	48–63
Flexural properties:		
Flexural strength (p.s.i. at break)	D790-49T	3300–10700
Rockwell hardness: (R scale)	D785-51	+15–106
Izod impact: (ft. lb./in. notch)	D256-43T	2.7–11.0
Heat distortion: (°C.)	D648-45T	51–70
Water absorption:		
% sol. lost	D570-42	0.00–0.08
% moisture gain	D570-42	1.5–1.8
% water absorption	D570-42	1.6–2.0

Celanese Corporation of America, Plastics Division
Dept. 184-S, 744 Broad Street, Newark 2, N. J.

Please send me New Product Bulletin A2A on Forticel Plastic.

Name_____

Title_____

Company_____

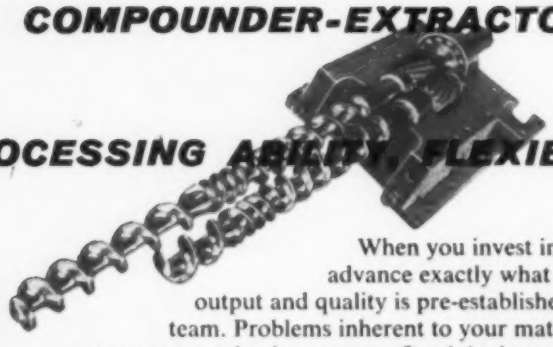
Address_____

City_____ Zone_____ State_____

THE UNIQUE WEI DUAL WORM DESIGN GIVES

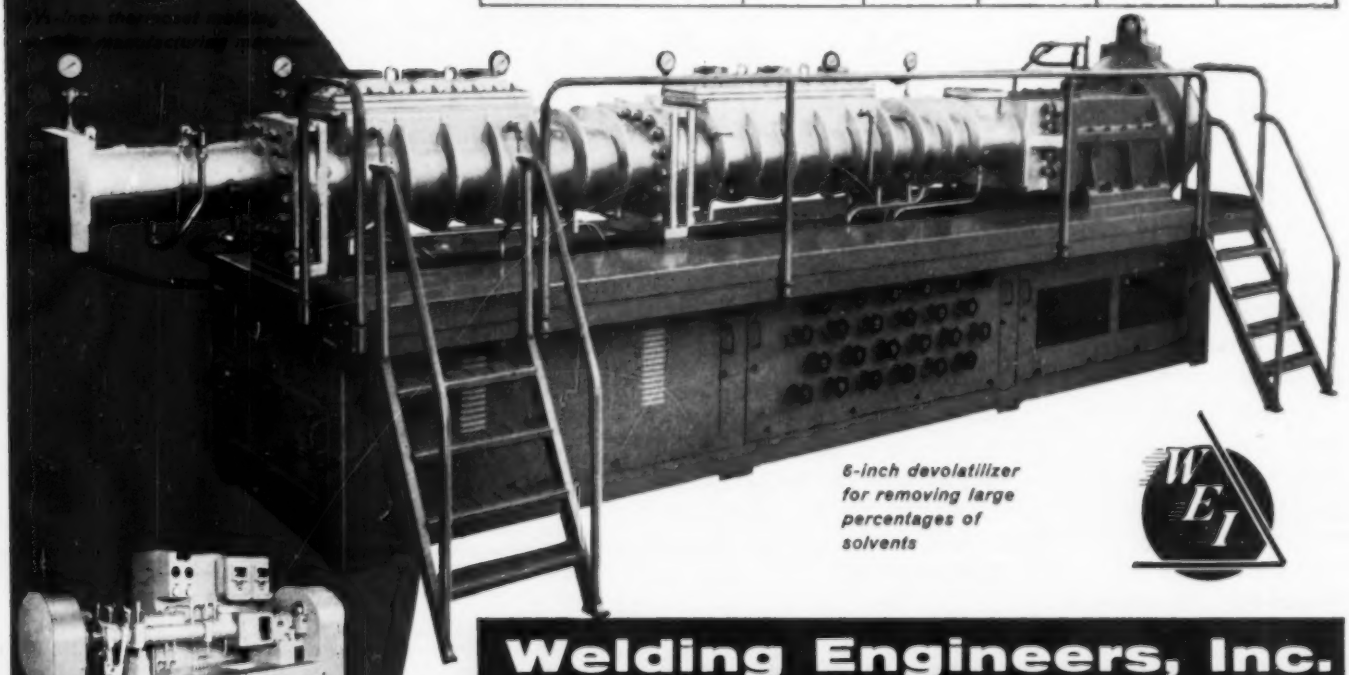
WELDING ENGINEERS COMPOUNDER-EXTRACTOR-EXTRUDERS

THE OPTIMUM IN PROCESSING ABILITY, FLEXIBILITY, OUTPUT



When you invest in WEI equipment you know in advance exactly what production you can count on: output and quality is pre-established by our research-engineering team. Problems inherent to your materials and your manufacturing processes are solved on custom-fitted dual worm equipment . . . labor-saving, space-saving, continuous all-in-one operation machines. In the whole range of thermoplastics . . . and rubber, as well . . . Welding Engineers compounding-extracting-extruding equipment continues as the most reliable in the service of America's foremost plastics and rubber manufacturers. Write for catalog No. 891.

	Series 2000	Series 3000	Series 3500	Series 4500	Series 6000
Dual Worms	each: 2" dia.	each: 2.8" dia.	each: 3.5" dia.	each: 4.5" dia.	each: 6.0" dia.
Feed Inlet At Worms	3½" dia.	5" dia.	6" dia.	8" dia.	10" dia.
Drive Motor For Standard Duty Machines	10 HP	25 HP	50 HP	100 HP	—
Drive Motor For Heavy Duty Machines	—	—	75 HP	150 HP	300 HP
Floor Space (Exclusive of Motor)	2' x 7'	3' x 8'	3'6" x 10'	4' x 14'	5' x 20'
Weight of Machines	2500 lbs.	4000 lbs.	6000 lbs.	8000 lbs.	28000 lbs.



8-inch devolatilizer for removing large percentages of solvents

Welding Engineers, Inc.

- West Coast Representatives—Machinery Sales Co Los Angeles 58, California
- Exclusive Sales Representatives for Europe and the British Isles—Welding Engineers Ltd Geneva, Geneva, Switzerland

PLASTICS
TECHNOLOGY

Influence of Resin and Process Variables on Polyester–Glass Laminate Properties

Experimental data describe the controlled effects of several resin properties, including modulus of elasticity, shrinkage, and reactivity.

A. L. SMITH, *Head,*
and
W. G. CARSON, *Staff Member,*
Develop. & Applications Lab. for Polyester Resins,
Rohm & Haas Co., Bristol, Pa.

ALTHOUGH much has been written about the ability of glass fibers to reinforce rigid plastics, relatively little has been said about the direct influence of various resin properties on glass-reinforced laminates. One reason for this may be that glass-laminate mechanical properties exceed those of the cast resin by an order of magnitude so that the reinforcing effect of the glass could be expected to overshadow any changes in laminate properties contributed by differences in resin properties or processing techniques.

Another reason may be that the direct influence of specific cast resin properties is hard to trace because the inter-relation between such properties makes their influences difficult to control independently. The importance of a knowledge of resin property influence on laminate characteristics lies in the fact that resin properties generally can be predesigned by chemical modification and, thus, some knowledge of their influences on laminates should permit better control over laminate characteristics.

This paper will describe an attempt to examine the direct influences of several controlled properties of polyester resins on laminate characteristics, together with the influence of two fabrication variables, press temperature and catalyst concentration, that became involved indirectly in this study.

There are a number of well-defined resin properties that conceivably could affect the characteristics of a laminate. Those properties whose influence is thought to be most pronounced are listed, as follows:

(1). Modulus of elasticity.
(2). Strength (tensile, flexural, and shear).
(3). Polymerization shrinkage.
(4). Reactivity (speed of gelation and cure, and exotherm peak).
(5). Change of modulus with temperature (H.D.T.).
(6). Coefficient of thermal expansion.
(7). Chemical characteristics possibly affecting glass attachment.

* Numbers in parentheses refer to bibliography at end of article.

This list undoubtedly is incomplete, and the properties are not necessarily presented in any order of importance. It also is apparent that many of these properties are interrelated. Thus, high strengths and moduli are usually found together because of the rigid, non-ductile nature of the resins. Also, fast reactivity and high H.D.T. accompany each other. Because of this interrelation, the controlled influence of only a few of the above properties was possible, but an indication of the influences of other properties under partially-controlled conditions also was obtained.

Experimental Method

All cast resin and laminate properties were determined according to standard ASTM testing procedures. Laminates were prepared from 12 plies of #181-Volan glass cloth, unless otherwise noted, arranged in a nested parallel lay-up (1)*. Resin was allowed to soak through the cloth after the cloth had been dried for one hour at 120° C. to remove surface moisture. Benzoyl peroxide was used to catalyze the resin in all cases. The resin content in the laminates was closely controlled by pressing against spacers.

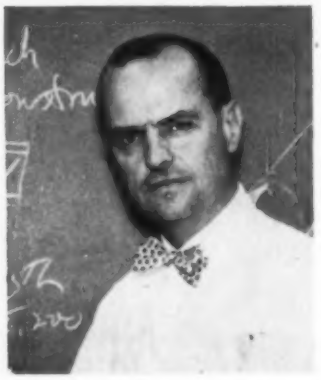
Test Results

Modulus of Elasticity

The over-all influence of resin modulus of elasticity on laminate modulus and flexural strength is shown in Figure 1. The points shown represent a variety of resins that differed rather widely with respect to physical properties. The only attempt made to control the influence of these properties was to press the laminates at a relatively low temperature (140° F.), but one that was felt to be high enough to effect complete cure. In this manner, the influence of differences in resin reactivity and of characteristics affected by temperature changes (such as H.D.T. and thermal expansion) largely was eliminated. Despite the considerable scatter of results shown, a definite trend is apparent and is one that would be expected intuitively.

Several means were considered for studying the influence of the resin modulus of elasticity on laminate properties that would be independent of the conflicting interference of other resin properties. One means of varying resin modulus without changing the other resin characteristics listed above, except for resin strength, would be to vary the testing temperature. By assuming that glass fiber properties and the resin-fiber bond would be unaffected by such a temperature variation, the influence of resin modulus on laminate properties could be determined in a controlled manner. However, recent work by Platts (2) indicates that the resin-fiber bond may be influenced considerably by temperature changes.

Since the extent of variations of this type was unknown, it was decided to study the influence of resin modulus by preparing a series of resins from various proportions of a rigid and a flexible polyester resin cross-linked with an amount of styrene designed to give constant polymerization shrinkage. Again, the specimen laminates were cured slowly and at a relatively low temperature. In this manner, a variation in resin modulus was obtained that was free from other influences, except for variations in resin strength and fairly slight changes in resin chemical composition. The influence of the modulus of elasticity of these resins on laminate strength is shown in Figure 2. Compared to Figure 1, there is less scatter in the data, but both pairs of curves are shaped similarly and the decrease in laminate strength with resin modulus is more pronounced than the decrease in laminate modulus in both cases.



Arthur L. Smith was born in Newark, N. J., in 1913, and attended Rensselaer Polytechnic Institute, receiving a B.S. in Chemical Engineering in 1935. Following graduation, he was associated with Benjamin Moore & Co. from 1935-1942, with M. W. Kellog Co. from 1942-1943, Rohm & Haas from 1943-1950, Continental Can Co. from 1950-1952, and returned to Rohm & Haas in 1952 where he now is Head of the Development & Applications Laboratory for Polyester Resins. His professional affiliations include memberships in A.C.S., SPE, and Sigma Xi. Mr. & Mrs. Smith have three children (a son and two daughters) and make their home in Jenkintown, Pa.

William G. Carson was born in Philadelphia, Pa., in 1923, and received an A.B. in 1944 from Swarthmore College and a Ph.D. in 1951 from Johns Hopkins University in 1951. He was with Synthane Corp. from 1944-1946, and has been with Rohm & Haas since 1951 and now is a Group Leader in the Development & Applications Laboratory for Polyester Resins. He, too, is a member of A.C.S., SPE, and Sigma Xi. Mr. & Mrs. Carson currently reside in Erlton, N. J.

Resin Strength

As mentioned above, there is a rather close correlation in rigid resins between modulus of elasticity and strength measured in tension, flexure, compression, or shear. Thus, it is not possible to determine closely the

influence of resin strength on laminate properties independently of resin modulus. As would be expected, laminate behavior as a function of resin strength closely parallels the situation found when resin modulus is the independent variable.

Figure 3 describes the relation between laminate modulus and strength and resin flexural strength for the data described in Figure 2. Figures 4 and 5 show how laminate flexural strength and modulus of elasticity vary with resin shear and tensile strength, respectively, for a series of different commercial resins with the laminates, in all cases, being cured at the same low temperature (140° F.).

Two points in Figure 4 are of special interest since they are well out of line with the other data. One of these points represents an epoxide resin; the other an experimental polyester resin which is outstanding in respect to its high glass-reinforced properties.

Polymerization Shrinkage

The shrinkage that occurs during the polymerization of a polyester resin is dependent principally on the degree of unsaturation in the polyester, the type of cross-linking monomer, and the polyester/monomer ratio. Because a greater degree of shrinkage occurs in the monomer than in the polyester portion of the resin on curing, variation in the polyester/styrene ratio can greatly affect the degree of polymerization shrinkage. When this ratio is changed, other properties, such as resin reactivity and H.D.T., also change.

In order to study the influence of resin shrinkage on laminate properties, two different polyesters, designated "X" and "Y", were each combined with varying amounts of a cross-linking monomer and shrinkages were determined from the differences in specific gravities of the liquid and cast resins. Results are given in Table 1. This table also lists the flexural strengths and moduli of elasticity of castings and laminates made from these resins.

It is seen from these results that cast resin strengths for the most part change rather slightly with shrinkage. Resin reactivity and resin properties affected by thermal changes largely were prevented from influencing laminate strengths by curing the laminates slowly at low temperatures, so that the only property listed at the start of the article that might have changed when shrinkage was varied by changing the polyester/monomer ratio was the chemical nature of the resin. A change of this type in resin chemical composition could influence laminate strength because of the greater tendency of the monomer, compared to the polyester, to copolymerize with the glass-fiber finish. At lower polyester/styrene ratios, therefore, improved attachment of the resin to glass might result independently of any shrinkage effects.

This specific point was checked by preparing a series of laminates from heat-cleaned glass cloth (#181 cloth, #112 finish). Laminate strengths varied with shrinkage in the same manner found with #181-Volan finish cloth used in making the other laminates. However, the possibility remains that resin-glass attachment might be affected in other ways by chemical composition changes resulting from polyester/styrene

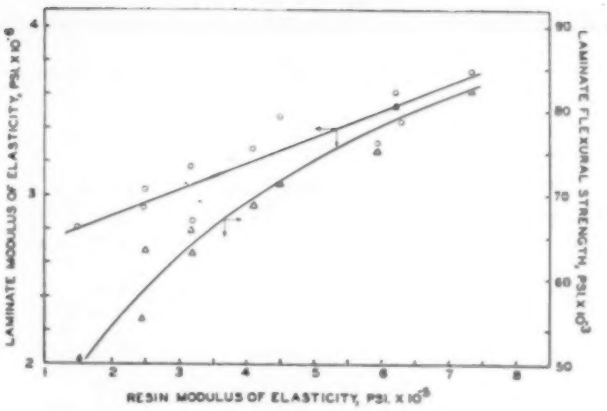


Fig. 1. Effect of modulus of elasticity for various polyester resins on flexural strength and modulus of elasticity for 12-ply laminate specimens made with 181 Glass Cloth-Volan finish.

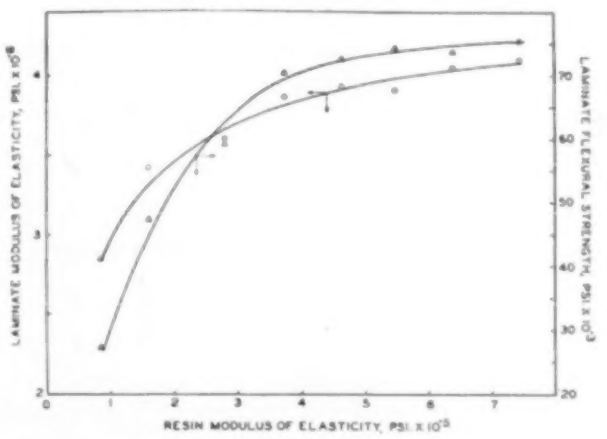


Fig. 2. Effect of modulus of elasticity for polyester resins with uniform shrinkage on flexural strength and modulus of elasticity properties for 12-ply laminate specimens reinforced with 181 Glass Cloth having Volan finish.

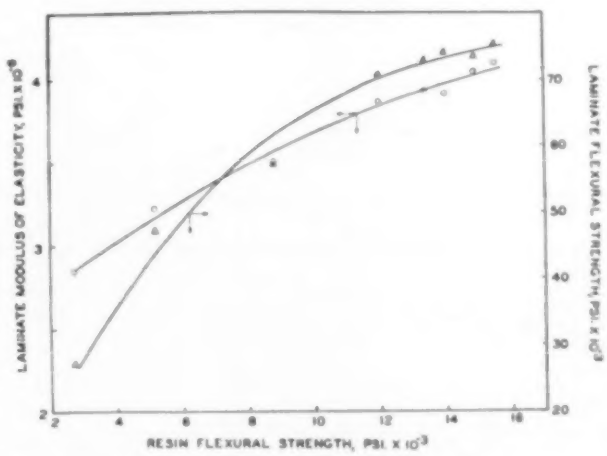


Fig. 3. Effect of flexural strengths for polyester resins with uniform shrinkage on modulus of elasticity and flexural strength properties of 12-ply laminate specimens with 181 Glass Cloth-Volan finish reinforcements.

Table 1. Influence of Resin Polymerization Shrinkage On Laminate Strength.

Polyester/Monomer	Wgt. Ratio	% Shrinkage	Casting		Laminate	
			Flex. Strength, Psi.	Flex. Modulus, x 10^{-5} Psi.	Flex. Strength, Psi.	Flex. Modulus, x 10^{-6} Psi.
X /Styrene	70/30	6.96	17,600	5.79	77,700	3.19
	50/50	9.18	17,400	5.36	77,800	3.25
	33/67	11.72	15,200	4.94	80,300	3.25
Y /Styrene	65/35	8.94	13,700	3.98	68,300	2.86
	50/50	9.68	13,400	4.27	71,100	2.95
	33/67	10.22	15,000	4.15	72,000	2.84
Y /MMA	65/35	10.72	14,600	5.08	77,100	3.61
	50/50	12.85	15,300	5.18	80,600	4.04
	33/67	15.15	15,000	5.16	84,800	4.16
	65/35	10.72	14,600	5.08	53.000*	3.04
	50/50	12.85	15,300	5.18	55,200*	3.14
	33/67	15.15	15,000	5.16	56,800*	3.34

* #181 glass cloth with #112 finish

Table 2. Influence of Catalyst Concentration and Press Temperature on Laminate Properties.

Resin	% Benzoyl Peroxide	Press Temperature, ° F.			
		140	225	250	300
		Flexural Strength, Psi. x 10^{-3}:			
A	0.5	—	76.0	74.0	62.4
	1.0	—	73.4	75.7	63.5
	2.0	—	75.4	76.0	58.7
	1.0 + 0.01% Quinone	—	—	74.9	55.7
B	0.5	65.0	56.7	—	46.8
	1.0	66.5	58.4	—	48.1
	2.0	64.6	58.3	—	53.9
		% White Light Transmittance:			
A	0.5	—	5.5	11.0	—
	1.0	—	10.0	10.0	—
	2.0	—	7.0	6.0	—
	1.0 + 0.01% Quinone	—	—	11.0	—
B	0.5	29.0	5.5	—	3.0
	1.0	30.0	4.0	—	2.5
	2.0	30.0	3.0	—	3.0
		Compressive Strength, Psi. x 10^{-3}:			
A	0.5	—	48.9	—	—
	1.0	—	55.1	—	—
	2.0	—	53.0	—	—
B	0.5	40.9	35.4	—	30.2
	1.0	40.7	36.6	—	32.9
	2.0	40.0	34.8	—	30.1

Table 3. Temperatures in Center of 12-Ply Laminates of Resin "A" During Cure.

% Benzoyl Peroxide	Press Temp., ° F.	Exotherm Peak Temp. Minus Press Temp., ° F.	Time Interval, Min.	
			150° F. to Peak	Press Temp. to Peak
1	217	14	2.10	1.50
1	253	29	1.00	0.40
1	300	53	0.40	0.10
0.5	235	13	2.18	1.20
1.0	235	20	1.51	0.84
2.0	235	43	1.02	0.54
1.0 + 0.01% Quinone	235	23	1.75	0.78

ratio variation.

A consideration of the data in Table 1 shows that a slight increase in laminate flexural strength and, usually, in modulus of elasticity results from an increase in resin shrinkage. This is in spite of the decrease in modulus of the resin itself that might occur as in the first three samples in Table 1. This shows the importance of keeping the shrinkage at a constant value in earlier studies (Figures 1, 2, 3).

This increase in laminate strength with resin shrinkage would tend to support the theory that a frictional attachment between resin and fiber largely is responsible for laminate strength, since the frictional force is proportional to the product of resin shrinkage (induced by both polymerization and thermal changes) and modulus of elasticity (3).

Resin Reactivity

The reactivity of a polyester resin generally is described in terms of the time required for the temperature of a curing rein to rise from a fixed or bath temperature to a peak temperature resulting from the exothermic polymerization reaction. This reaction time and the maximum temperature differ widely with different resins. They also are greatly influenced by the type and concentration of catalyst and the reaction temperature.

Because of the difficulties connected with chemical modification of the resin to achieve a controlled variation in reactivity, it was decided to study the influence of reactivity on laminate properties by varying reactivity with changes in press temperature and catalyst concentration. It was recognized in doing this, however, that side influences from differences in thermal expansion and H.D.T. might be difficult to separate from the influence of a change in reactivity. For this work, three rigid resins were selected that differed considerably in reactivity and other properties. These resins have been designated "A", "B", and "C".

The first method of varying reactivity was to change the press temperature used in making the laminate. When this was done, marked changes were noted in a variety of laminate properties. Other investigators, including Hooper (4), also have shown that the strengths of polyester laminates vary considerably with changes in curing temperature.

Figures 6 and 7 describe the changes in glass-cloth laminate flexural and compressive strengths with press temperature over the range from 140-300° F. Similar results are found with mat laminates. In addition, laminate translucency and water absorption also change appreciably, as shown in Figures 8 and 9.

The decreases encountered in laminate properties as the press temperature is raised undoubtedly are due to cracks forming in the laminate. The translucency and water absorption changes alone support this conclusion. It is well known that unfilled polyester resins undergo cracking when cured at too fast a rate, either because of too high a temperature or too large a catalyst concentration. Thus, it was felt that changes in laminate properties similar to those found with press temperature variations could be induced by changing the catalyst concentration. When this was done, however, no ap-

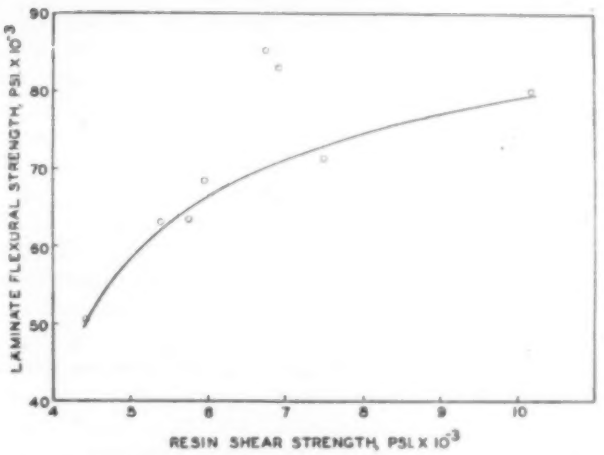


Fig. 4. Effect of shear strength for various polyester resins on flexural strength of 12-ply laminate specimens made with 181 Glass Cloth-Volan finish.

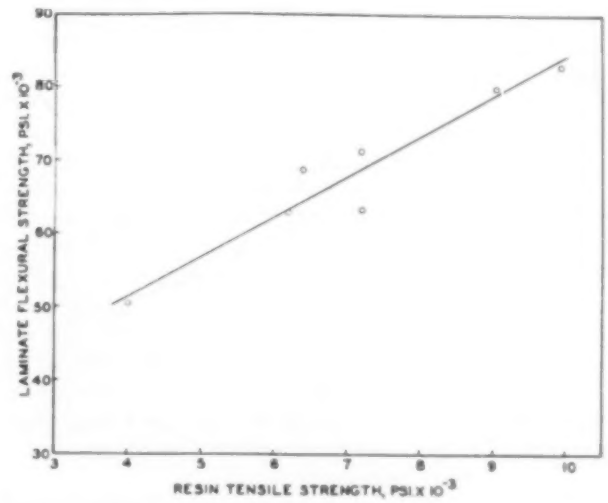


Fig. 5. Effect of tensile strength for various polyester resins on flexural strength of 12-ply laminate specimens made with 181 Glass Cloth-Volan finish.

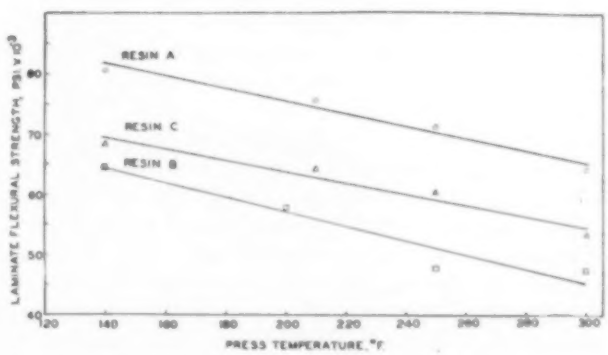


Fig. 6. Effect of press temperature for three polyester resins on flexural strength of 12-ply laminate specimens made with 181 Glass Cloth-Volan finish.

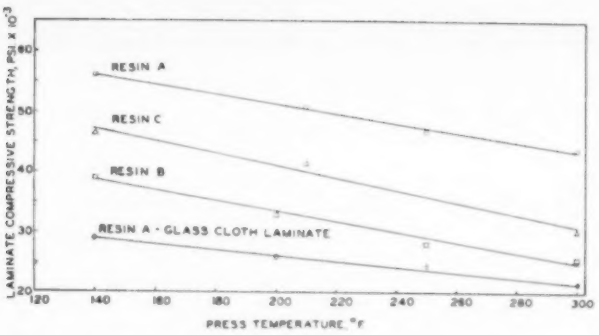


Fig. 7. Effect of press temperature on edgewise compressive strengths of 12-ply laminate specimens made with 181 Glass Cloth-Volan finish.

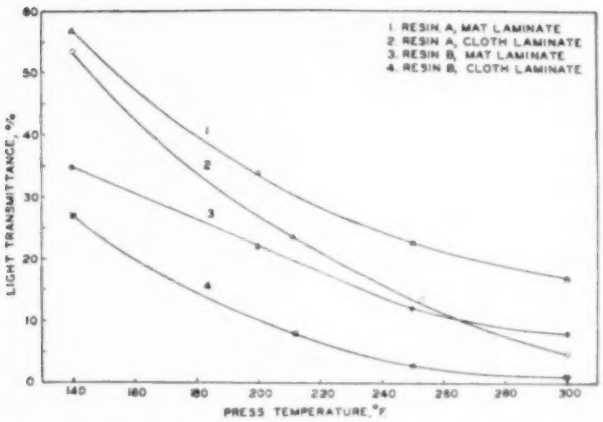

1. RESIN A, MAT LAMINATE
2. RESIN A, CLOTH LAMINATE
3. RESIN B, MAT LAMINATE
4. RESIN B, CLOTH LAMINATE
LIGHT TRANSMITTANCE, %
PRESS TEMPERATURE, °F

Fig. 8. Effect of press temperature on white light transmittance properties of polyester-glass cloth and mat laminates.

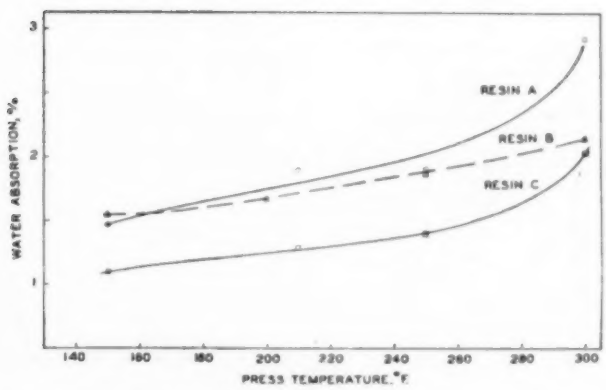


Fig. 9. Effect of press temperature on water absorption after 24 hours at 100° C. for 12-ply laminate specimens made with 181 Glass Cloth-Volan finish.

preciable changes in laminate properties were found. These results are given in Table 2 where a four-fold variation in catalyst concentration with two different resins over a 150° F. temperature range is described.

In order to determine why the catalyst concentration changes did not have more effect on laminate properties, temperature changes during cure in laminates made with different catalyst concentrations and at different press temperatures were measured with thermocouples. These results are listed in Table 3. The temperature through the laminate thickness was determined similarly, but only slight differences were found. Thus, a thermocouple embedded between the two central plies of a 12-ply laminate registered a peak exotherm that was only 15° F. higher than the exotherm found with a thermocouple placed between an outer ply and the ply next to it. The time intervals recorded by these two thermocouples for the temperature to rise from the press temperature to the exotherm peak approximately were the same.

Changes in peak exotherm temperature with catalyst concentration variation are roughly equivalent to those found by varying the press temperature. Since differences in laminate properties resulted only when press temperature changes were made, this would indicate that the peak exotherm temperature during cure is not of much significance.

The reactivity of the resin has been compared arbitrarily in Table 3 in terms of the time intervals for the resin to rise in temperature from 150° F., the approximate temperature at which the benzoyl peroxide begins to decompose to the peak exotherm temperature. Similar time intervals for the temperature to rise from the press temperature to the exotherm peak also are listed. The differences in reactivity of the resin resulting from press temperature variation are found, by this means of comparision, to be somewhat greater than reactivity differences caused by catalyst concentration changes.

It would seem, therefore, that the rate of reaction of the resin influences the extent of cracking that occurs on curing. It is probable that a wider variation of catalyst concentration, which would have caused a greater change in resin reactivity than was found in the samples studied, might have had an influence on laminate properties. However, the absence of greater laminate property differences within the range of catalyst contents studied is somewhat surprising.

The fact that differences in laminate properties are observed with press temperature variation and not with catalyst concentration changes might indicate that stresses arising from differences in thermal expansion between resin and glass are of major importance. Visual observation of the laminates indicates that most cracks are parallel to the fibers and could result from shear stresses at the resin-glass interface caused by expansion differences. Cracks parallel to the fibers also could result from the shrinking resin pulling away from the fibers, especially where spacers are used to control laminate thickness (as in this study). Without spacers, follow-up pressure applied during cure could be expected to largely eliminate this type of cracking.

In order to examine further the influence of resin reactivity rate on the laminate, two other experiments were performed. A laminate was prepared in which

quinone was added to the resin to retard the start of reaction. Reactivity results are shown in Table 3. The addition of the inhibitor did not appreciably influence the exotherm peak temperature or the rate of reaction after the laminate temperature had reached the press temperature. This modification of the resin also did not affect laminate strength or translucency, indicating that the early stages of resin curing probably are not critical in their effects on laminate properties. Here, again, the variation in resin reactivity by this modification might not have been sufficiently great to cause significant changes in the laminate properties.

A second experiment was run to determine the influence of resin reactivity as varied by the rate of heat transfer to the laminate. For this study, laminates were prepared by clamping the uncured lay-ups between glass plates and placing them in an oven to cure. With this arrangement, it was possible to watch translucency changes in the laminate, while temperature changes were determined simultaneously by means of a thermocouple. The degree of translucency was determined only qualitatively, since refractive index changes of resin and glass with temperature interfere with attempts to measure translucency changes because of cracking.

The laminates were prepared from Resin "A" catalyzed with 1% benzoyl peroxide and 12 piles of #181-Volan glass cloth. After the liquid resin had wet the cloth, the white light transmission was about 60%. One lay-up was clamped between glass plates at room temperature and placed in a 235° F. oven. The temperature in the center of the laminate rose slowly from room temperature to oven temperature in about one hour, and no exotherm was observed. The opacity of the laminate became somewhat greater as the cure progressed, and reached a maximum at about the same time when the laminate attained oven temperature.

A second laminate was clamped rapidly between glass plates pre-heated to oven temperature (235° F.), and the assembly then placed quickly in the oven. The temperature in this laminate rose quickly, and the elapsed time from 150° F. (approximate decomposition temperature of the catalyst) to the peak exotherm temperature was 3.4 minutes. The exotherm peak, however, was only 2° F. above oven temperature. This laminate attained a maximum degree of opacity in about 10 minutes. Both laminates were removed from the oven after the resin was adequately cured.

Light transmission through the first sample was 38.5% while light transmission in the sample cured between the hot plates was 20.5%. Flexural strengths and moduli for these laminates were 79,800 psi. and 4.33×10^6 psi. for the slow cure, and 72,900 psi. and 4.06×10^6 psi. for the faster cure. Only a slight change in transparency in these laminates was noted as they cooled from oven temperature down to room temperature, and this could be accounted for by differences in the rates of change of the resin and glass refractive indices over the temperature range. These results definitely point to the fact that the rate of cure of the resin has a more important influence on laminate properties than the exotherm peak which was virtually the same in both the laminates studied.

Assuming that cracks in the laminate chiefly are responsible for the changes observed in laminate properties when the press temperature is changed; the question then is the nature of the origin of these cracks. Cracking can be assumed to occur when internal stresses exceed local strength. Such stresses would result from the strains produced principally by resin shrinkage. Also, the 10-fold difference in thermal expansions between the resin and glass could be expected to cause shear stresses at the resin-glass interface under some conditions.

The magnitude of stresses in a curing resin would be dependent on the strain and the modulus of the curing resin and the temperature dependence of the modulus of the curing resin. This situation obviously is quite complex, but its analysis would be quite valuable to determine how laminate properties might be improved. Shrinkage and temperature measurements during resin cure are relatively simple to make, but the determination of the modulus and strength of a resin as it is curing presents many problems. This must be done, however, if the phenomenon of cracking is to be fully understood. One approach to the determination of stresses in a curing resin currently is being studied (5). The procedure used involves determining stresses on the interior of a thin metal cylinder immersed in curing resin with strain gauges mounted on the interior of the cylinder.

It may be concluded from this study of the influence of resin reactivity that the rate at which a resin cures, as determined roughly by the rate at which resin temperature rises, is of more importance than the actual peak to which the temperature rises. When this rate of cure, as influenced particularly by curing temperature, is too great, cracking results mainly at the resin-fiber interface, but also in the resin itself, and the laminate properties suffer. The extent of cracking probably is influenced by other factors such as the manner in which resin rigidity increases with increasing shrinkage, and how rigidity varies with temperature.

Conclusions

The observations made above lead to the general conclusion that for best laminate properties, a resin should have a high modulus and strength. Polymerization shrinkage should be as high as possible without being great enough to cause internal stresses in the resin that would lead to cracking. The reactivity of the resin should be controlled so that the cure would not take place too rapidly. This would largely prevent cracking from occurring, since the stresses that cause cracking thereby would have more opportunity for relaxing.

For high laminate strength, a resin should have a modulus that would fall off rapidly with increasing temperature (low H.D.T.) so that stresses arising during cure would be reduced by the temperature encountered while curing. A low heat-distortion temperature, however, would not be desirable if laminate strength at elevated temperature was required. The thermal expansion of an optimum resin should be low so that shear stresses arising at the glass-resin interface due to the lower thermal expansion of glass could be kept at a minimum.

(Continued on page 840)

D. D. McCOLLISTER, *In charge of Research on Chronic Oral Toxicity, (left)*
and
W. J. SAUBER, *Plastics Customer Service Engr., Dow Chemical Co., Midland, Mich. (right)*

Health Safety of Plastics

A review and discussion of the underlying principles and procedures needed to evaluate plastics for food-contact applications

ANY manufacturer must assure himself of sufficient knowledge of the chemical, physical, and physiological properties of his product in order to feel certain that it is suitable for an intended use. There are both moral and legal obligations for so doing, and such a philosophy always is good business practice. Thus, plastics for use in food packaging and housewares must be evaluated for safety from the public health aspect. An understanding of the roles of the material supplier, government agency, and fabricator is the necessary and important first step in providing plastic food packages and housewares that will create no public health problems.

In many instances, plastics have replaced other materials such as wood, paper, fabric or metal in food-packaging applications. Certainly, plastics have many unique and desirable properties in solving problems of prolonging shelf-life for packaged food, plus the fact that their use has a great enhancement in the advertising and display of foodstuffs in the market place. In such uses, the plastic container (or any container for that matter) may come into prolonged and intimate contact with a packaged foodstuff. Thus, it is possible that some quantity of one or more of the components of the container may migrate into the food product, resulting in contamination, or adulteration. The official governmental food regulatory agencies have given particular attention to plastic films and containers during the past 10 years.

Safety Evaluation

The evaluation of safety of plastics used in food packaging passes through several phases, but all are designed to assist in answering one or both of two basic questions:

(1). Are any of the components of the plastic formulation getting into the packaged food? If so, how much?

(2). Is there a public health problem indicated by whatever amounts may be found?

Before answering either of these questions, an exact description of the formulation must be known. Besides the base polymer or copolymer, what emulsifier, plasticizer, lubricant, stabilizer and other addition agents are used, and in what concentrations? Also, a description of the proposed application, including kind of package (film or molded container, for example), and the type of food products to be packaged are desirable information. Much of this information, obviously, is obtainable only from the manufacturer.

Extraction Studies

With such information, the manufacturer may conduct extraction studies; tests in which representative food products, or simulated food products, are stored in contact with the plastic product. Usually, it is found in the extraction test that natural food products pose

Revised and enlarged from a paper presented at the Annual Technical Conference, Society of Plastics Engineers, Inc., Detroit, Mich., Jan. 29, 1958.

problems of interference with the analytical methods. With most packages, it is desirable to cover a variety of food types. Therefore, simulated food products are employed almost routinely in such tests.

These may include water made slightly alkaline with sodium bicarbonate or slightly acid with acetic acid to simulate most water-base foods. To simulate fatty foods, various fats or oils (such as Crisco, vegetable oils, peanut oil, lard oil or paraffin oils) have been used. Storage for periods of 1-4 weeks, and temperatures up to 212° F. for short periods and 120° F. for longer periods may be maintained. Large surface-of-plastic to volume-of-extractant ratios may be employed to enhance the sensitivity of the analytical method. All of these conditions are intended to represent the most extreme conditions of service shelf life.

The simulated food solvents then are analyzed for suspected contaminants. At this point, the progress of the whole project may hinge on the adequacy of analytical methods (they must be able to identify each extractable substance). The first objective, if possible, is to show that none of a particular chemical substance is likely to be found in the food. Therefore, analytical techniques may be required to show "nil" with a certainty of as low as 0.1 part per million or, in certain cases, a sensitivity of 0.01 part per million may be necessary.

Toxicity Studies

For those components of the plastic formulation where there is a possibility of the chemical occurring in the packaged food, there arises a second question; "Is there a public health problem?" For aid in this decision, toxicological data are needed. "Toxicity" is a term often used to mean "health safety." However, "toxicity" used in this connection usually means: "What is the safety when used in contact with food? Is the material suitable from the toxicological viewpoint?"

To the layman, a "toxic" substance may mean something that is rapidly fatal if an indeterminate amount is swallowed, breathed, or gotten on the skin. Toxicity actually is a property that can be described for any substance, including such common materials as salt and bicarbonate of soda. It is the capability of the material to cause injury to the living organism by other than mechanical means. Being a property of matter, it is definable in quantitative terms. Thus, even the most common materials are toxic when encountered under certain conditions in sufficient quantity. It is simply a matter of degree.

Toxic effects result when "too much" of the material is contacted. Thus, how much is "too much?" Some materials are relatively safe in that large quantities may be contacted before harmful effects occur. For example, one or two aspirin tablets may relieve a severe headache for most persons, but half a bottle or so may well prove fatal to a child who swallows them all at one time. Putting it another way, even "safe" materials have toxic levels. Ethyl alcohol in various forms is known to be harmless. However, it may cause marked "toxic" effects when large amounts are swallowed within a short period of time.

As one learns that all substances have their own toxic levels, it becomes evident also that some lower level exists for any substance at which no harmful effects whatsoever will occur, even when encountered repeatedly. As an example of this concept, carbon monoxide from an automobile exhaust reaches dangerour concentrations almost immediately to a man in the closed garage, but is harmless in the small amounts that may be encountered daily on the open highway. The objective of the toxicological study is to determine the safe level of an extractable component of a plastic food packaging formulation. If and when such studies are done depends on "extraction." If neither the base resin nor any of the addition agents are extracted into the food, there is no public health problem regardless of the toxicity of any of the materials.

Toxicological Studies

Necessary toxicological data may be obtained, usually by experiments on laboratory animals at a cost now estimated at $50,000 or more per material. Such studies also require research facilities, such as those of Dow's Biochemical Research Laboratories. In a 40,000 square-foot building area, the Toxicology Section utilizes approximately 22,000 square feet.

Experiments with laboratory animals are conducted to obtain information necessary for the protection of the lives and well-being of human subjects. These may include:

(1). Effects of feeding single oral doses of a material to a number of animal species (such as rat, rabbits, guinea pigs, mice and dogs). The data may be expressed as a figure known as the acute oral LD^{50}; a statistical value representing the quantity expected to kill 50% of the group of animals fed.

(2). Ninety-day feeding in the diet of rats to determine short-term effects from repeated swallowing of small amounts. The test chemicals are mixed into the animals' food in different proportions.

(3). Lifetime (two-year) feeding in the diet of rats, and one-year feeding to dogs to determine the long-term effects from repeated swallowings of small amounts. The maximum quantity causing "no effect" is sought.

In these studies, the criteria for judging adverse effects upon the animals include growth wherein body weights are obtained frequently. Records also are kept of food consumption, mortality, and general appearance and behavior. Further tests include clinical blood and urine chemistries, and hematology. At the end of the experiment, many of the animals are autopsied. Average weights of the liver, kidneys and other vital organs are obtained, and the animal tissues are examined under the microscope by the pathologist. In addition, special studies may be carried out to determine the absorption, distribution, elimination and metabolic fate of the test substance within the animal body.

With "extraction" and "toxicological" data at hand, the toxicologist is faced now with a final decision concerning the suitability of a plastic formulation for use in food packaging or housewares. Regardless of the extensive toxicological and other data that may be available, a certain element of risk exists in any affirmative decision.

*Numbers in parentheses refer to Bibliography at end of article.

Health safety in this situation has been described (1)* as "the practical certainty that no harm will result from a substance when used in a proposed quantity and manner." This definition of health safety places emphasis on the practical certainty, thus implying that a reasonable amount of toxicological data should be sufficient. Absolute certainty in proving "no harm" raises the difficult question, "How far must one go to prove a negative?" This definition also recognizes that it is not the plastic formulation itself being evaluated, rather its safety in the manner of proposed use!

It is of utmost importance, therefore, that the decision to market a product intended for food-contact application be based on the sound judgment of scientifically trained, experienced personnel who must weigh all factual data and legal requirements. This means persons qualified to correlate data on composition, nature and type of application, design of extractability tests (including adequacy of analytical methods), and with experience in the interpretation of toxicological data.

Legal Studies

The manufacturer, having satisfied himself that a plastic is a safe suitable material for food packaging or housewares also must consider certain legal requirements. He then may discuss his data with appropriate federal, state, or other outside agencies concerned with protection of the public food supply. There are a number of state and local agencies that may have legal jurisdiction, including various divisions of the United States Public Health Service or state and city Public Health Departments. In the case of plastic pipe for potable water supply, the National Sanitation Foundation has been established as an advisory group.

Two agencies at the federal level with headquarters in Washington D. C. have particularly important regulatory responsibilities and powers. One of these is the Food and Drug Administration, which is part of the Department of Health, Education and Welfare. This agency administers the Food, Drug and Cosmetic Act of 1938. Under this Act, there is no licensing, or prior approval, mandatory before foods packaged in plastic containers can be shipped and sold. The burden of safety is on the shipper; the burden of proof is on the Food and Drug Administration which may seize and impound such shipment if it contains or is suspected to contain a material that is in violation of the Federal Act.

In the past, officials of the United States Food and Drug Administration, Division of Pharmacology, have held informal conferences to discuss data and problems of health that might occur from the use of plastic food containers. Subsequently, the manufacturer might have obtained a letter stating that the FDA sees "no objection" to the use of a specific formulation in food-contact applications. Such "informal tolerance" proceedings, however, were not provided in the 1938 Law.

Brief mention should be made at this point of proposals now before Congress designed to strengthen the Food and Drug Law with regard to "chemical additives." Representatives of industry, government, universities and consultant laboratories appear agreed generally on legislative changes placing more direct responsibility for safety on the producer. It is expected that new legislation will establish a formal procedure by which the manufacturer is required to present safety evaluation data to FDA prior to use of his plastic product, a time-table is established for a decision by FDA, and the petitioner may appeal an adverse ruling to the courts or to an advisory committee for review.

The other federal agency that should be mentioned is the Meat Inspection Division, Agricultural Research Services, of the U. S. Department of Agriculture. This well-established agency administers the Meat Inspection Act of 1906. Unlike the Food and Drug Act, the Meat Inspection Act requires a definite, written approval prior to the use of many different materials, including plastics, in contact with meat or meat food products prepared in a federally-inspected plant. A letter of "acceptance" from this agency may be used judiciously as a reference when advertising the product.

(*Continued on page 838*)

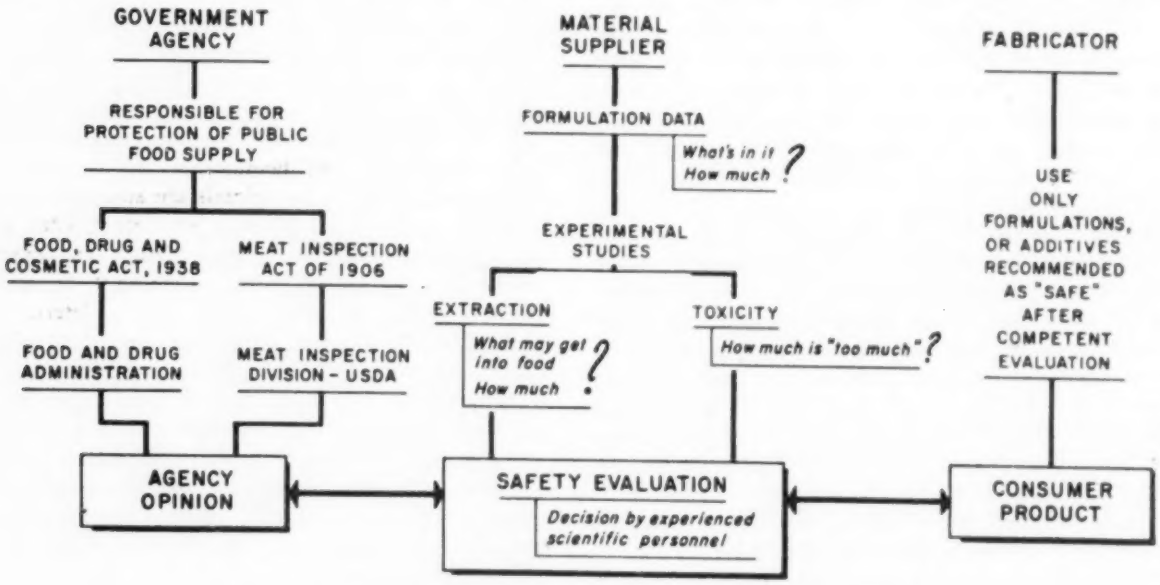


Fig. 1. Development of a plastic material for food-contact applications

Guest Editorial

A. E. GABRIEL, *Research Project Leader, Evans Research & Development Corp., New York, N. Y.*

Research: The Key to the Plastics Crisis

PRACTICALLY no industry in our history can point to a recent past as exciting and fruitful as that of plastics. The last 15 years have seen its phenomenal growth with unprecedented prosperity to a point where four billion pounds has become the annual product. In the four years from 1946 to 1950, its volume increased 100%; in the next four years, 30% over that. But the figures for the years since, with much more modest growth, indicate that a state of crisis is approaching and an agonizing reappraisal is in order. There are already signs and portents. For one thing, annual productive capacity is now 200,000,000 pounds ahead of consumption. What does all this mean to the producer, manufacturer, processor, converter, and distributor?

Perhaps more than any other industry, plastics is almost purely a creation of the laboratory. Half a century of attempts to synthesize the natural cellulose resins could not reproduce their unique characteristics of strength, heat resistance, and other properties. Then, around the turn of the century and in the early decades that followed, progress was made in great leaps. A series of sensational "break-throughs" spearheaded by Baekeland and his laboratories gave rise, particularly with other discoveries in the 20's and 30's, to the birth of the industry in the form we know today.

As a creation of the laboratory, the plastics industry depends far more than any other on one universal basis—research. In turn, other industries wait on plastics for their further advance and development. Revolutions in construction, automobiles, agriculture, machine tools, and almost every other industry, are tied to plastics and paced by their growth.

Yet, paradoxically, the plastics field since World War II has developed into a highly competitive business, with little room for the marginal producer and the static businessman. There is practically no such thing as a staple in plastics; properties must be and are constantly being improved, new applications found and perfected, and new forms of "old" standbys developed. This is an industry which thrives on the new, and can only grow on the new and the better.

Thus, no matter from what angle the approach is made, the avenue always remains the same—research. Research today means extraordinary capital investments and requires unusual scientific and technical knowledge. To the average company, and frequently even to the large company, it means facilities and personnel out of its reach. A large company's laboratory often cannot tackle a particular problem because of weight of work involved in keeping production lines going and continuing with the research projects that are long in progress. The smaller company is shut out from all such activity, except that most vital to its immediate operation.

In a larger sense, how is the manufacturer to know whether his future lies in silicones, high-density polyethylene, or polypropylene? Should he investigate the linear polymeric synthetics or the new epoxy resins? Should he improve the product he has or find a new one he can profitably substitute for it? Should he continue as he has been or should he adapt his facilities to other products? Does his new idea have practical validity for him? Can it be easily produced? Will it do all that he thinks it will? These are all questions for

which the answers must come out of the laboratory, and on these answers depend the life of his business and its profits.

Pacing the growth of the plastics industry is another, far smaller in its size and volume, but as essential to that growth as research itself. It is that of the independent industrial research laboratory which has established itself as an indispensable organ in the plastics industrial structure.

"Independent laboratory" conjures up a picture of an advertising illustration with a man in a white coat. Nothing could be farther from the truth. The functions of the independent industrial research laboratory might range from keeping tabs for a client on technical literature in a given field to the sensory evaluation of paint odors. With the competence and completeness of personnel and facilities of such a laboratory, one of the greatest assets that it brings to bear on any subject is that of the fresh, unbiased viewpoint. The "outside" laboratory is unhindered in its approach by production pressures, preconceived notions, or the dozens of other urgencies that impose themselves upon the "inside" laboratory.

Taking Evans Research as an example, the primary step is consultation with the client to define the problem. It is an amazing truth that many problems brought to the laboratory are ill-defined; even, at times, undefined completely and existing merely as vague or random thoughts. It is equally amazing that the mere process of definition and analysis, in consultation, can sometimes resolve or eliminate the problem for the client without the necessity for any additional work.

From this initial definition and analysis emerges the true nature of the problem. Perhaps it boils down to a change in the formulation of plastic used for piping a certain acid to prevent its corrosion; perhaps a slight design change to make a complex molded part three times stronger than it is; perhaps a slightly different vinyl to provide an extra margin of safety in wire insulation; perhaps a new bonding resin to make two new materials laminate properly. There is practically no limit to the range and variety of projects in plastics that the well-qualified independent laboratory can undertake within the borders of known science. Nor is it the single laboratory staffer that gets the assignment. In our organization, for example, there are 60 qualified scientists, supplementing and complementing one another over the vast field of scientific knowledge, who operate as a team, with the necessary skills and bodies of knowledge pooled to provide the best thinking on any given problem.

How else is it possible to tackle the dramatic new opportunities presented by the latest developments in plastics chemistry, such as untold possibilities in the new catalysts and their effects on the polymerization of molecules, and the approach to 100% crystallinity of plastics; or applications, plastics harder or more durable or stronger than metals. Suppose the chemistry and possible uses both are solved. Then, how to produce them, machine them, make them adhere, remove odors, eliminate toxicity, reduce their cost, color them, make them transparent, and so on through an unending host of questions until, finally solved, their replacement with newer and better plastics materials starts the cycle again.

The dozens of commercially-used monomers already synthesized form the bases for hundreds of combinations up to the extremely complex polymers now under observation at the highest levels of research. Their almost living growth, linking, alignment and coiling are more easily predicted and more accurately charted as work proceeeds with the newer catalysts mentioned and the newer electronic measuring instruments. The effects of radiation on branching and cross-linking of polymers, as well as their electrical properties, are problems awaiting further investigation for their solution, along with the continuing investigations into monomer and polymer combinations, and graft and block polymerization. Eventually, understanding and control will unfold the mechanism for producing super-high molecular weights. Meanwhile, there are many things theoretically possible, but not yet harnessed to the practicalities of application or production. All these factors have important bearings on almost every problem requiring laboratory attention.

It is the extremely rare "inside" (company) laboratory that has the talent to give a problem the widest possible approach, with constant awareness of the factors outlined, unburdened by other work or routine affairs. There is another great advantage of the "outside" laboratory. Any subject is approached from the truly "outside" without preconception or misconception, without interference or disruptions, and without causing disruptions of its own.

This approach is the same whether the independent laboratory is used by the very largest of companies for overflow of work from its own laboratories, for special testing, for product or production trouble-shooting, for developing a new product to meet a given need or improving an old one, for one-time "rental" of highly specialized knowledge or equipment, for practical advice on diversification or, as noted, for maintaining a watchful eye and supplying abstracts of technical literature on a topic of interest. It should be mentioned that every reputable independent industrial research laboratory, usually a member of the American Council of Independent Laboratories, as a matter of course assigns any patents developed during a project and in any way related to it to the client for whom the project has been undertaken.

There seems no more adequate or practical method of solving the unnumerable problems of modern plastics development, production and application than the use of such a laboratory. All industry waits on the results of research investigations into every aspect of our production economy. There is room for the imaginative and daring if it is also practical and qualitatively superior at the right price.

This can no longer be accomplished by the lonely scientist of the past, working with great dedication in his laboratory for 25 years while seeking the one great discovery. Nor can the average company spend the millions of dollars required for exploitation of the great discoveries. Their sights and their achievements generally are more modest in scope and within the realm of practicality. To define the problem and to find the most expedient and reasonable solution to it is the

(Continued on page 838)

R. E. MONICA, *Section Head*
Extrusion Sect., Plastics Technical Service
The Dow Chemical Co., Midland, Mich.

What a Plastics Engineer Should Look For When Planning to Buy an Extrusion Machine

WHEN purchasing an extrusion machine, advanced planning on the part of the engineer is extremely important. Sufficient time must be allowed for contacts with equipment suppliers to determine machine specifications, delivery times, costs, etc. In addition to the time needed to determine the type of equipment to purchase, time is needed to prepare the area where the extrusion machine will be operated. Responsibility for the planning should be vested in one man; however, this engineer will want to consult the various departments involved to obtain their ideas. He then should follow the project through to final installation at the plant site.

At the outset, the engineer should have an analysis from his management as to the expected performance of the machine both immediately and in the future. This will undoubtedly be the largest single factor in determining the size of the machine to be purchased. For example, if the proposed use of the machine for a five-year period is to manufacture fine-denier monofilaments, a 2½ inch extruder would be considered. On the other hand, if thick sheeting is to be the major product of the firm, a 4½ inch extruder might be a better choice.

Extruder sizes are determined by screw diameter and length. The more common sizes of American extruders have screw diameters of 1½, 2, 2½, 4½, and 6 inches, respectively. For special jobs such as mixing, preheating and dispersing, extruders have been built with screw diameters ranging from 8 to 24-inches in diameter. Over-all extruder size often is expressed as screw length to diameter ratio (L/D). For instance, a 2½ inch extruder with a 20:1 L/D ratio would have an effective screw length of 50 inches. Plastic extrusion machines are available with L/D ratios of 17:1, to 24:1, with the bulk of the extruders supplied having a 20:1 L/D ratio.

Extruder outputs vary with L/D ratios, as well as with screw diameters. The size and shape of the part being extruded often will have an effect on the poundage the extrusion machine will put out in a given time. The engineer should rely on the experience of the machine builders in obtaining output rate estimates for a given extrusion.

The engineer must have a knowledge of the type of materials on which the extruder will be operating. Screw designs are available from the leading equipment suppliers for use with the major material families. Although it is often possible to run different materials

with the same screw, optimum results will be obtained by having a properly designed screw for each material family which is to be extruded.

Most equipment suppliers offer screws that are cored to accommodate cooling media. Screw cooling is not necessary for all plastic materials, but it is well to have the option of screw cooling whether it is used or not.

Extruder heating methods often are the subject of lively debates. Electricity, steam, oil and, more recently, induction heating are methods used to heat the extruder cylinder. Each method has its advantages and disadvantages, and each should be considered in the light of utilities cost, site preparation, maintenance, and initial investment.

No matter which heating method is employed, careful consideration must be given to methods of controlling the cylinder temperatures during extrusion. Cylinders usually contain three or four heating zones, and each must be controlled individually. Proper instrumentation is necessary to assure constant delivery of a uniformly heated plastic mass to the extrusion die.

In many cases, it becomes necessary to remove heat from the cylinder during operation. With a gaseous or liquid heating medium, such as steam or oil, this is no problem. With electrically heated machines, however, some means of effectively cooling the cylinder must be employed. Cooling coils and air fans have proven satisfactory in this regard.

Means of attaching the desired extrusion die to the extruder should be investigated by the engineer. The head and gate of the extruder should allow for a breaker plate and screen pack, and should fit the cylinder end accurately to avoid leakage.

Manufacturers Specifications

Manufacturers of extruders list principal specifications of their machines. These specifications, together with blueprints and descriptive literature, should be gathered by the engineer and studied thoroughly to see how a given machine will fill his needs. In addition to including information on screw diameter and length, the specifications will have information as to the materials of construction for the screw and cylinder, the number of heating zones in the cylinder, the heating system, the drive, and may contain some estimate of the machine output. The latter can be quite confusing, as the output depends largely on the shape of the extruded part, the plastic material being extruded, the power available, and other factors. The engineer should call on the experiences of the extruder manufacturer to get accurate production rate estimates. He then will be able to correlate these rates with his own needs and be in a position to purchase the correct size extruder for his operations.

The specifications usually will contain information on the type and size of drive. Several different types of drives are in use today:

(1). AC-DC drives, in which an AC motor drives a direct current generator that, in turn feeds a DC motor. Speed is regulated by varying the voltage.

(2). Magnetic clutch drives, in which a magnetic eddy-current clutch serves as a coupling device between an AC motor and the extruder. Speed change is affected by varying the degree of coupling.

(3). Mechanical types, such as belt or chain drives running between two variable-diameter pulleys. The engineer should consider items such as speed regulation, maintenance, and initial cost when choosing the drive for an extruder.

Auxiliary Equipment

In addition to studying the extruder proper, the engineer must be aware of the auxiliary equipment needed for successful operation of the machine. Equipment manufacturers supply hoppers large enough to feed the screw of the extruder. It is well to specify hopper size in connection with anticipated extruder output. A good rule of thumb is to specify a hopper of sufficient size to hold a minimum of one hour's output of the extruder.

Feed hopper dryers are useful auxiliary equipment. Certain plastic materials must be preheated prior to extrusion to obtain good extruded parts. Most observers feel that hopper drying is beneficial when used with any plastic material, since drying often will result in increased production rates.

Hopper loaders that pneumatically convey pellets from drum or bag to the extruder hopper are available from several manufacturers. Naturally, loaders result in labor savings in the extrusion plant.

Special Features

The engineer may wish to investigate special features that are incorporated into otherwise standard machines. These features include vented or devolatilizing extruders, in which a vent is cut into the cylinder to allow for removal of volatile during extrusion, and valved extrusion in which a valve is placed on the machine head to control plastic pressure during extrusion. The engineer can analyze his job to determine the necessity for employing these devices at additional expense.

Customer Service and Maintenance

The customer service and maintenance service offered by the machine builder is an important consideration. It is important to determine the type and extent of service offered by each machine builder, including service and delivery on spare parts. Many machine builders have access to laboratories or plants where their equipment can be seen in actual operation. The engineer should take advantage of this opportunity to see equipment running on related jobs.

Plant Lay-out

If the extruder is being installed in a new plant, advanced planning is necessary for good lay-out. Provisions must be made for water, power, air drains, etc. It is well to lay this utility service out under the assumption that additional extruders will be added at some future time. In laying out the plant, the flow of material through the plant should be considered. Provision must be made for the receipt of raw materials. Space should be provided for material preparation prior to extrusion which may include drying, coloring,

(Continued on Page 828)

PT's Comparative Data c

Manufacturer*	Aetna-Standard					Davis-Standard			
Extruder name and model no. (if any)...	1½	2½	3½	4½	6	Model 25T	Model 35T	Model 45T	Mode
Number of screws.....	One	One	One	One	One	One	One	One	O
Screw: Diameter, inches.....	1½	2½	3½	4½	6	2½	3½	4½	
Effective length, inches.....	30	50	70	90	144	50 (20:1) 38¾ (15:1)	70 (20:1) 54¼ (15:1)	90 (20:1) 69 (15:1)	120 (92 (
Speed range, rpm.....	33-200	19-150	19-152	40-125	40-120	Up to 200	Up to 150	Up to 110	Up
Design type.....	Metering type screw with adjustable valve.					Constant lead, diminishing depth or any type to			
Barrel pressure range, psi.....	10,000	10,000	10,000	10,000	10,000	Std. Furnished with 7,500 psi. shear pin or clamp higher.			
L/D ratio, excluding feed opening.....	20:1	20:1	20:1	20:1	24:1	20:1 15.5:1	20:1 15.4:1	20:1 15.3:1	2 15
Input brake hp.....	5	25	50	75	125-150	64 with 1.25 service factor.	107 with 1.25 service factor.	152 with 1.25 service factor.	209 1.25 fa
Extrusion capacity, lbs./hr., based on polyethylene (20,000 mol. wt., 4.0 melt index, 0.92 sp. gr.) at 500 ± 1° F. with output rate held to ± 1%.....	60	150	300	600	1,000-1,200	200 at 3,000 psi.	400 at 3,000 psi.	600 at 3,000 psi	90 3,000
Gear reduction type.....	Single Reduction, Helical.	Double Reduction, Herringbone or Helical.				Helical	Helical	Helica	He
Thrust carrier: Type.....	Entire thrust load transmitted back to cast steel feed cylinder.					Roller bearing.	Roller bearing.	Roller bearing.	R bea
Life rating, hrs., at 100 rpm. and 5,000 psi....	15,000*	25,000 Min.	19,800 Min.	150,000 Min.	150,000 Min.	825,000	252,000	450,000	25
Materials, base and surfacing, for: Screw.....	Alloy steel forgings, with Stellite on tips of screw flights.					SAE 4147 leaded steel, hardened and polished			
Feed cylinder.....	Cast steel with Xaloy Liner.					Xaloy liner.	Xaloy liner.	Xaloy liner.	X li
Lubricating system.....	Submerged Dip Lubrication.					Oil pump driven by input shaft.			
Heaters: Type.....	Induction Coils—60 cycle current—220 or 440V. line voltage or low voltage.					Therma-Fin (electric)	Therma-Fin (electric)	Therma-Fin (electric)	Ther (el
Control.....	Three-position controllers with thermocouple break protection.					Proportioning controllers for each cylinder zone.			
Number of zones.....	3	3	4	4	5	4 for 20:1 3 for 15:1	4 for 20:1 3 for 15:1	4 for 20:1 3 for 15:1	Each ma-F two heat troll tiosi trol
Max. kw. demand on barrel...	3.6	8	17.0	30.0	60.0	20	28	40	
Approx. heat-up time, min., from room temp. to 500° F. (for polyethylene specified above).....	24	40	48	50	64	15	25	30	
Hp. of: Drive.....	—	41**	61**	94**	240**	60	100	150	
Motor.....	5	25	50	75	125-150	To customer's specifications, not to exceed drive			
Special features of standard units.....	Portable model plus other features listed for larger sizes.	Thrust capacity up to 10,000 psi. Automatic cooling with water, steam, or air. Screw adjusting mechanism to vary internal pressure while operating. Quick-opening high pressure head. Close temperature control at high temperature. Temperatures up to 700° F. easily maintained. Base designed to accommodate coating dies. Pressure gauges installed both sides of valve.				Completely wired control panels. Electric st Separate thrust and radial bearings. Labyrinth feed section. Oversized stainless steel hoppers indicators. Screw flights extend beyond feed thr Four-splined stock screw with tapered drive end ture control. Wide-opening head clamp. Head machine. V-belt drive. Easily removed feed th gage. Water-cooled screw fittings.			
Optional features.....	—	Special carriage for retraction of extruder. Rectangular or circular feed opening.				L:D ratios and screw designs to order. Cored c couples and pressure gages. Complete selection er without electric heating. Valved heads.			
Approx. floor space (L x W), feet.....	5⅜ x 2½	9⅜ x 6⅜	12½ x 6	15½ x 6½	21⅜ x 7⅛	7 x 2	9 x 2½	12 x 3	1
Approx. delivery time, weeks.....	10-12#	16-18#	16-20#	18-20#	18-20#	12-14	12-14	12-14	

* Average life at 200 Rpm. and 10,000 psi.

** American Gear Manufacturers Association's Class 1 mechanical horsepower rating for the gear reducer when the output shaft speed (screw speed) is 100 Rpm.

Will vary with amount of engineering required, and backlog of work.

Note: Aetna-Standard also produces standard pressure (3,000 psi.) extruders in sizes from 1½" through 12"—steam, oil, or electric heat. In addition, they have developed successful designs for 2½" and 3½" twin screw extruders featuring improved thrust capacity and longer bearing life.

Data on Extrusion Machines

s-Standard

Model 45T	Model 60T	Model 90T
One	One	One
4½	6	8
90 (20:1) 69 (15:1)	120 (20:1) 92 (15:1)	160 (20:1) 122½ (15:1)
Up to 110	Up to 85	Up to 60
th or any type to specifications.		
shear pin or clamp, or to 10,000 psi. and		
20:1 15.3:1	20:1 15.3:1	20:1 15.3:1
152 with .25 service factor.	209 with 1.25 service factor.	308 with 1.25 service factor.
600 at 3,000 psi	900 at 3,000 psi.	1,500 at 3,000 psi.
Helica	Helical	Herringbone
Roller bearing.	Roller bearing.	Roller bearing.
450,000	252,000	196,300
d and polished		
Xaloy liner.	Xaloy liner.	Xaloy liner.
Therma-Fin (electric)	Therma-Fin (electric)	Therma-Fin (electric)
ach cylinder zone.		
4 for 20:1 3 for 15:1	Each model has two Therma-Fins, two blowers, and two sealing dampers in each heat zone. Each pair is controlled by a single proportioning instrument on control panel.	
40	56	80
30	40	60
150	200	300
ot to exceed drive rating.		
nels. Electric stock screw tachometer. rings. Labyrinth oil seals. Water-cooled ss steel hoppers with shut-off and level beyond feed throats. One-piece cylinder. tapered drive end. Therma-Fin Tempera- ad clamp. Head support swings clear of removed feed throat bushing. Visual oil gs.		
to order. Cored or solid screws. Thermo- mplete selection of heads to order, with lved heads.		
12 x 3	15 x 3½	20 x 4½
12-14	12-14	12-14

Johnson

JMC 1½	JMC 2½	JMC 3½	JMC 4½	JMC 6
One	One	One	One	One
1½	2½	3½	4	6
31½	52½	73½	94½	126
125 max.	125 max.	110 max.	100 max.	90 max.
—	—	—	—	—
12,000 max.	10,000 max.	10,000 max.	10,000 max.	10,000 max.
21:1	21:1	21:1	21:1	21:1
—	—	—	—	—
—	—	—	—	—
Herringbone	Herringbone	Herringbone	Herringbone	Herringbone
Spherical roller thrust bearing.				
200,000	81,000	61,000	36,000	47,000
Rycut 50 steel with hardened flight and hard chrome surfacing.				
Alloy steel with Xaloy and Xaloy 306 surfacing.				
Flood lubrication through thrust assembly.				
Glenn Electric Star-Flex tubular resistance heaters.				
Proportioning	Proportioning	Proportioning	Proportioning	Proportioning
2	3	3	4	5
9*	24*	22*	42*	87*
—	—	—	—	—
5-15	15-30	25-30	40-75	75-150
—	—	—	—	—
Electric heaters removable from aluminum housings. Electric interlock to prevent starting motor before heat is up. Individual heater-indicator lights. Air-cooling to each zone. Prewired control panel. Flexible coupling connection from reducer to thrust.				
Induction heating. Pressure-control heads.				
2 x 5¼**	2½ x 8½**	3¹/₁₆ x 11¹/₁₆**	3⅝ x 13½**	4⅝ x 17⅜**
6	6	8	10	14

* Using 500-watt heater.
** Less motor.

Electrophysical (E. P. E.

Inductomatic D-250	Inductomatic D-350	Inductomatic D-450	Inductomatic D-600
One	One	One	One
2½	3½	4½	6
50	70	90	114
7-120	6-100	5-90	4-75
Custom, to customer's requirements.			
10,000	10,000	10,000	10,000
19:1	19:1	19:1	19:1
—	—	—	—
1.27*	2.89*	5.5*	11.25*
Herringbone	Herringbone	Herringbone	Herringbone
Cyl. roller	Cyl. roller	Cyl. roller	Cyl. roller
20,000 min.	13,200 avg.	12,600 avg.	12,600 avg.
Nitraloy	Nitraloy	Nitraloy	Nitraloy
4142 steel, Xaloy-306 liner.	4142 steel, Xaloy-306 liner.	4142 steel, Xaloy-306 liner.	4142 steel, Xaloy-306 liner.
Immersion	Immersion	Immersion	Immersion
Induction	Induction	Induction	Induction
Proportioning	Proportioning	Proportioning	Proportioning
3	4	4	4
13.5	27	33.6	48
30	40	50	60
44	80	101	156
20	40	60	100
Perfect heat control. Forced-air cooling. One-die heat control zone.			
16:1-30:1 L/D ratios	16:1-30:1 L/D ratios	16:1-30:1 L/D ratios	16:1-30:1 L/D ratios
Pressure gages. Melt-temperature indicators.			
6 x 2	8⅜ x 2¾	12 x 4	14¾ x 4½
4	6	6	16

* Free-Flow rate.

Egan

Manufacturer*									
Extruder name and model no. (if any)...	2	2½	2½	2½ Vented	3½	3½	3½ Vented	4½	4
Number of screws.....	One	One	One	One	One	One	One	One	On
Screw: Diameter, inches.....	2	2½	2½	2½	3½	3½	3½	4½	4
Effective length, inches.....	40	50	60	80	70	84	112	90	10
Speed range, rpm.....	Ranges up to 500 rpm. can be provided, normally limited to screw peripheral speeds of 1500 inches per minute.								
Design type.....	Metering, nylon, and full-flighted designs with various compression ratios cored for fluid heating and cooling available, de								
Barrel pressure range, psi.....	For continuous working pressures in excess of 20,000 psi.								
L/D ratio, excluding feed opening.....	20:1	20:1	24:1	32:1	20:1	24:1	32:1	20:1	24
Input brake hp.....	Suitable for continuous 100% input HP.								
Extrusion capacity, lbs./hr., based on polyethylene (20,000 mol. wt., 4.0 melt index, 0.92 sp. gr.) at 500±1° F. with output rate held to ±1%.....	75	120	150	***	250	280	***	420	4
Gear reduction type.....	Herringbone type.	Herringbone type.	Herringbone type.	Herringbone type.	Herringbone type.	Herringbone type.	Herringbone type.	Herringbone type.	Herrin ty
Thrust carrier: Type.....	Heavy-duty roller type in self-contained housing.								
Life rating, hrs., at 100 rpm. and 5,000 psi....	200,000*	46,000*	46,000*	46,000*	21,000*	21,000*	21,000*	30,000*	30,0
Materials, base and surfacing, for: Screw.....	Cut from solid alloy, heat-treated steel bar stock with flame-hardened, chrome-plated flights and surfaces.								
Feed cylinder.....	One-piece centrifugally cast steel with integral Xaloy or Xaloy 306 liner.								
Lubricating system.....	Continuous forced-feed lubrication.								
Heaters: Type.....	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Cer
Control.....	Willert Temperature Control System with three position, proportioning type temperature controllers for heat and cooling.								
Number of zones.....	2	3	4	5	3	4	5	4	
Max. kw. demand on barrel...	16**	24**	28**	28**	36**	42**	42**	60**	7
Approx. heat-up time, min., from room temp. to 500° F. (for polyethylene specified above).....	30	30	30	30	30	30	30	30	1
Hp. of: Drive.....	Up to 15	Up to 25	Up to 30	Up to 30	Up to 50	Up to 50	Up to 75	Up to 100	Up t
Motor.....	Up to 15	Up to 25	Up to 30	Up to 30	Up to 50	Up to 50	Up to 75	Up to 100	Up
Special features of standard units.....	Separate feed box section with tangential feed opening jacketed for water cooling and separated from heating cylinder to mechanical AC-DC eddy-current clutch, etc., variable speed motor drives, as required. Timing or V-belts normally us Heater bands and thermocouples prewired to a terminal strip. Water piping and drain lines have common connection. Guards around cylinder and all moving parts.								
Optional features.....	Screws with stellited, nitrided, or pre-hardened and chrome-plated flights also available. Direct coupling optional on plastic melt temperature. Screw extractors. Heater burn-out detection lights. Indicators for motor loads. Air-operated he Pre-heat cylinder timers. Calrod, induction-types, and thermostrip heaters available on cylinder. Willert Temperature and torpedo patterns available. Extruder sizes 10-inch and larger custom built to meet requirements.								
Approx. floor space (L x W), feet.....	4 x 8	4 x 10	4 x 11	4 x 14	5 x 12	5 x 13	5 x 16	7 x 13	7 x
Approx. delivery time, weeks.....	2	2	3	4	2	4	5	6	

* Life expectancy of 90% of all bearings.
** Maximum Kw. demand on cylinder.
*** Mostly used for compounding, ratings vary with use. Estimates available upon request.

Welding Engineers

Manufacturer*									
Extruder name and model no. (if any)...	2" Special	2"-2052V1	2"-2052RV2	2.5"-2552V1	2.5"-2552CX	3.5"-3542B	3.5"-3552V1	3.5"-HH3552V2	3.5"-H3500DX
Number of screws.....	Two	Two	Two	Two	Two	Two	Two	Two	Two
Screw: Diameter, inches.....	2	2	2	2.5	2.5	3.5	3.5	3.5	3.5
Effective length, inches.....	40-84	50	50	70	70	70	87½	87½	147
Speed range, rpm.....	150 max.	150 max.	150 max.	150 max.	150 max.	150 max.	150 max.	150 max.	150 max.
Design type.....	Full-flighted, metering, or wide variety of special types.								

Egan

4½	4½	4½ Vented	6	6	6 Vented	8	8	8 Vented
One	One	One	One	One	One	One	One	One
4½	4½	4½	6	6	6	8	8	8
90	108	144	120	144	192	160	192	256
ute.								
oling available, depending on application								
20:1	24:1	32:1	20:1	24:1	32:1	20:1	24:1	32:1
420	480	***	650	780	***	1,200	1,600	***
rringbone type.	Herringbone type.	Herringbone type.	Herringbone type.	Herringbone type.	Herringbone type.	Herringbone type.	Herringbone type.	Herringbone type.
30,000*	30,000*	30,000*	16,000*	16,000*	16,000*	20,000*	20,000*	20,000*
Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic
heat and cooling.								
4	4	5	4	4	5	4	5	5
60**	72**	72**	120**	160**	160**	192**	240**	240**
30	30	30	30	30	30	30	30	30
Up to 100	Up to 100	Up to 150	Up to 150	Up to 200	Up to 250	Up to 250	Up to 250	Up to 500
Up to 100	Up to 100	Up to 150	Up to 150	Up to 200	Up to 250	Up to 250	Up to 250	Up to 500

ating cylinder to minimize heat losses, lined with Xaloy or meehanite. Extruders furnished with constant-speed motors or -belts normally used between motor drive and reducers. Prewired temperature control panel with proportioning-type controller. mmon connection. Hopper has cut-off slide, sight glasses, and emptying chute. Breaker plate standard. Head clamp standard.

upling optional on drive. Swing gate for headclamp. Screw speed indicator. Pressure gage for back-pressure. Assembly to indicate . Air- operated head clamps. Cartridge type filter adapter. Back-pressure regulating valves. Stepless temperature controller. illert Temperature Control system on extrusion cylinder when cooling is needed. Special screw designs with variable flight pitches

7 x 13	7 x 15	7 x 18	8 x 15	8 x 17	8 x 21	9 x 19	9 x 22	9 x 26
6	8	10	6	10	12	12	12	16

Killion

K	K1	K2	K3	K4
One	One	One	One	One
0.75	1½	2½	3½	4½
12;16	24;30	40;50	56;70	72;90
20–45	20–90	25–150	20–150	20–150
As specified by customer.				
—	—	—	—	—
16:1,20:1	16:1,20:1	16:1,20:1	16:1,20:1	16:1,20:1
—	—	—	—	—
5–8	30–50	65–100	150–200	250–325
Gear box	Chain & sprocket.	Chain & sprocket.	Chain & sprocket.	Chain & sprocket.
Ball	Ball bearing.	Roller bearing.	Roller bearing.	Roller bearing.
5,000	15,000+	30,000+	30,000+	30,000+
Alloy steel, flame-hardened or hard-surfaced.				
Stainless steel or Xaloy.	Xaloy	Xaloy	Xaloy	Xaloy
Self-contained.	Splash lubrication.	Splash lubrication.	Splash lubrication.	Splash lubrication.
Electric bands.	Electric bands.	Electric bands.	Electric bands.	Electric bands.
Thermo-static	Thermo-static	Thermo-static	Thermo-static	Thermo-static
Barrel—2 Die—1	Barrel—2 or 3 Die—1	Barrel—2 or 3 Die—1 or 2	Barrel—3 Die—1 or 2	Barrel—3 or 4 Die—1 or 2
1.2	20.0	30.0	80.0	80.0
0.25	.33	0.5	0.5	0.5
¾	3–5	7½–10	20–25	40
½ or ¾	3–5	7½–10	20–25	40
—	—	—	—	—
Machines can be built to customers' specifications.				
1 x 2	2 x 5	3 x 7	4 x 8	4 x 10
2	4	6	6	10

Engineers

.V2	3.5"-H3500DX	4.5"-4542B	4.5"-HH4552V1	4.5"-HH4552RV2	6"-6052V1	6"-6052RV2	6"-6000DX
	Two	Two	Two	Two	Two	Two	Two
	3.5	4.5	4.5	4.5	6	6	6
½	147	90	112½	112½	150	150	252
z.	150 max.	150 max.	150 max.	150 max.	150 max.	150 max.	150 max.

NRM

Model 50–12	Model 55–1½	Model EH or IH 55–2½	Model EH or IH 55–3½	Model EH or IH 55–4½	Model 55–6	Model 55–8
One	One	One	One	One	One	One
1	1½	2½	3½	4½	6	8
—	—	—	—	—	—	—
21.3–58.7; 48–132	12–80 13–80	5–74; 11–73	4.4–70.4; 12–73	6–72; 4–70, 9–75	3.5–69; 6–73	5–55; 3–54
2 standard designs.	4 standard designs.	4 standard designs.	4 standard designs.	4 standard designs.	4 standard designs.	4 standard designs.

Welding Engineers (Cont'd)

Barrel pressure range, psi	2,000	2,000	2,000	2,000	2,000	2,000	2,000	4,000	2,000	2,000	4,000
L/D ratio, excluding feed opening	25–42	25	25	25	25	20	25	25	42	20	25
Input brake hp	10	10	10	25	25	50	50	75	60	100	150
Extrusion capacity, lbs./hr., based on polyethylene (20,000 mol. wt., 4.0 melt index, 0.92 sp. gr.) at 500 ± 1° F. with output rate held to ± 1%	125*	125*	125*	300*	300*	500*	500*	500*	500*	1,000*	1,000*
Gear reduction type	Spur gear	Spur gear	Spur gear	Planetary	Planetary	Planetary	Planetary	Planetary	Planetary	Planetary	Planetary
Thrust carrier: Type	Ball bearing.	Ball bearing.	Ball bearing.	Spherical roller bearing.	Spherical roller bearing.	Spherical roller bearing.	Spherical roller bearing.	Spherical roller bearing.	Spherical roller bearing.	Spherical roller bearing.	Spherical roller bearing.
Life rating, hrs., at 100 rpm. and 5,000 psi	80,000**	80,000**	80,000**	100,000**	100,000**	100,000**	100,000**	140,000#	80,000**	120,000**	160,000#
Materials, base and surfacing, for: Screw	Stainless steel, stellited.	Stainless steel, stellited.	Stainless steel, stellited.	Stainless steel, stellited.	Stainless steel, stellited.	Stainless steel, stellited.	Stainless steel, stellited.	Stainless steel, stellited.	Stainless steel, stellited.	Stainless steel, stellited.	Stainless steel, stellited.
Feed cylinder	Xaloy 306	Xaloy 306	Xaloy 306	Xaloy 306	Xaloy 306	Xaloy 306	Xaloy 306	Xaloy 306	Xaloy 306	Xaloy 306	Xaloy 306
Lubricating system	Splash type	Splash type	Splash type	Splash type	Splash type	Splash type	Splash type	Splash type	Splash type	Forced circulation.	
Heaters: Type	Hot oil circulation.	Hot oil circulation.	Hot oil circulation.	Hot oil circulation.	Hot oil circulation.	Hot oil circulation.	Hot oil circulation.	Hot oil circulation.	Hot oil circulation.	Hot oil circulation.	Hot oil circulation.
Control	Thermostat	Thermostat	Thermostat	Thermostat	Thermostat	Thermostat	Thermostat	Thermostat	Thermostat	Thermostat	Thermostat
Number of zones	5–8	6	6	6	6	5	6	6	8	5	6
Max. kw. demand on barrel	20	14	14	28	28	56	56	56	56	56	56
Approx. heat-up time, min., from room temp. to 500° F. (for polyethylene specified above)	45	45	45	60	60	60	60	60	60	75	75
Hp. of: Drive	10	10	10	25	25	50	50	75	60	100	150
Motor	10	10	25	25	25	50	50	75	60	100	150
Special features of standard units	Compounder-Extractor-Extruder.										
	Lab. test unit. Can be assembled for various barrel lengths & types.	Small-vent lab. or production unit.	Large-vent unit. Adjustable pressure treatment.	Small-vent unit.	No-vent unit.	Small-vent unit.	Small-vent unit.	Large-vent unit.	Extra-large vent unit.	Small-vent unit.	Small-vent unit.
Optional features	All types of variable speed drives, explosion-proof construction, quick-opening dies, screening heads, strand dies, hot-cut pelletizing systems, special dies, and other individual requirements.										
Approx. floor space (L x W), feet	7 x 2	7 x 2	7 x 2	8 x 3	8 x 3	10 x 3½	10 x 3½	10 x 3½	13 x 3½	14 x 4	14 x 4
Approx. delivery time, weeks	24	20	20	24	24	26	26	26	28	30	30

* When processing raw crumb feed of low-pressure polyethylene.
** Rated at 2,000 psi.
# Rated at 4,000 psi

Hartig

Manufacturer*											
Extruder name and model no. (if any)	Model #½		Model #1		Model #2	Model #3		Model #4		Model #5	
Number of screws	One	One	One	One	One	One	One	One	One	One	One
Screw: Diameter, inches	1¼	1½	2	2½	3¼	3½	4½	6	8	10	11
Effective length, inches	21½	31¼	31-1/16–60½	38–75¼	44¾–97½	73½	60#–135	89¾–180¼	112–240	210	84;252

NRM (Cont'd)

4,000	4,000	4,000	4,000	4,000	—	—	—	—	—	—	—
25	25	25	25	42	12:1	20:1	20:1	20:1	20:1	20:1	20:1
150	150	300	300	300	—	—	—	—	—	—	—
1,000*	1,000*	2,000*	2,000*	2,000*	6–10*	30–42*	80–115*	160–230*	275–375*	450–675*	1,200–1,600*
Planetary	Planetary	Planetary	Planetary	Planetary	Gear & belt	Chain type	Cone worm	Herringbone	Herringbone	Herringbone	Herringbone
Spherical roller bearing.	Spherical roller bearing.	Spherical roller bearing.	Spherical roller bearing.	Spherical roller bearing.	—	—	—	—	—	—	—
160,000#	160,000#	160,000#	160,000#	160,000#	5,225**	18,900***	87,500***	103,000****	146,000****	267,000####	318,000####
Stainless steel, stellited.	Stainless steel, stellited.	Stainless steel, stellited.	Stainless steel, stellited.	Stainless steel, stellited.	Alloy steel, chrome-plated, surface-hardened.						
Xaloy 306	Xaloy 306	Xaloy 306	Xaloy 306	Xaloy 306	1-pc. steel with Xaloy 306 liner.						
—	Automatic	Automatic	Automatic	Automatic	Automatic	Automatic
Hot oil circulation.	Hot oil circulation.	Hot oil circulation.	Hot oil circulation.	Hot oil circulation.	Band	Cast-in	Cast-in or induction type.	Cast-in or induction type.	Cast-in or induction type.	Cast-in	Cast-in
Thermostat	Thermostat	Thermostat	Thermostat	Thermostat	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning
6	6	6	6	6	2	2	4	4	5	5	6
56	56	120	152	168	1.2	5.1	13.75	25.8	38.5	62	100
75	75	90	90	90	—	—	—	—	—	—	—
150	150	300	300	300	—	—	—	—	—	—	—
150	150	300	300	300	¾	5	15	25	50	100	150
					Table model.						
Small-vent unit.	Large-vent unit. Adjustable pressure treatment.	Small-vent unit.	Large-vent unit. Adjustable pressure treatment.	Extra-large vent unit.	Light-weight, removable cylinder cover. Fabricated steel cabinet for controls. Prewired.						
					Entire unit mounted on one solid base plate.	Quick-changing die adapter gate.					
						Fabricated sturdy steel base.					
						Balanced heat control in each zone.					
cial dies, and other special features and equipment available to meet indi-					Other screw designs to order.						
					Other electrical characteristics available. Vari-pitch sheave for speed adjustment. 17:1 model available in vented & unvented types at 1.8 kw rating. Wire-covering crosshead & tubing die available.	Balanced heat control optional.	Drive motor optional. Choice of drive ratios. Different dies, take-offs, take-ups, cooling tanks and conveyors optional.				
							Oil & steam heating models optional. Auto. valve-controlled heat dampers.	Oil & steam heating models available.	Oil & steam heating models available.	Oil & steam heating models available.	Large extruders, screw sizes 6–15 inches, can be supplied, as can devolatilizing extruders.
14 x 4	14 x 4	20 x 5	20 x 5	26 x 5	2-11/12 x 2¼#	4-1/12 x 1⅜###	6¾ x 2-1/12###	9¼ x 3###	12 x 3¼###	14¾ x 4###	—
30	30	35	35	35	4–6 weeks for standard equipment.						

* Nominal capacity.
** Pounds at 100 rpm
*** Pounds at 40 rpm.
# Bench space.
Pounds at 44 rpm.
Not including separate electrical control cabinet.
Pounds at 60 rpm.
Pounds at 25 rpm.

Royle

Model #5	#½	#1	#1A	#2	#3	#4	#2A	#3A	#4A	#5A	#6A
One	One	One	One	One	One	One	One	One	One	One	One
11	1¼	2	2½	3½	4½	4½	6	6	8½	10	12
84;252	30⅝	48	60	84	90	103	108	120	127½	140	168

Hartig (Cont'd)

Manufacturer*										
Speed range, rpm	—	—	—	—	—	—	—	—	—	—
Design type	Plastic, metering, blister, and special design screws.									
Barrel pressure range, psi	—	—	—	—	—	—	—	—	—	—
L/D ratio, excluding feed opening	19:1	21:1	15:1–30:1	15:1–30:1	14:1–30:1	21:1	14:1–30:1	15:1–30:1	14:1–30:1	21:1
Input brake hp	—	—	—	—	—	—	—	—	—	—
Extrusion capacity, lbs./hr., based on polyethylene (20,000 mol. wt., 4.0 melt index, 0.92 sp. gr.) at 500±1° F. with output rate held to ±1%	10*	15*	60–110*	90–140*	150–230*	225*	250–400*	500–900*	800–1,500*	—
Gear reduction type	DeLaval	DeLaval	Herringbone	Herringbone	Herringbone	Herringbone	Herringbone	Herringbone	Herringbone	Herringbone
Thrust carrier: Type	SKF spherical roller bearings for radial and thrust loads.									
Life rating, hrs., at 100 rpm and 5,000 psi	—	—	—	—	—	—	—	—	—	—
Materials, base and surfacing, for: Screw	Hardened Nitraloy	Hardened Nitraloy	Hardened alloy steel	Hardened alloy steel	Steel base, Colmonoy #56 surface.					
Feed cylinder	Steel with cast Xaloy or Xaloy 306 lining.									
Lubricating system	All reducers splash-lubricated; other bearings pressure-fed by Manzel Lubrication.									
Heaters: Type	Cast-aluminum or bronze Calrod, mica, or Thermastrip heaters.									
Control	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning
Number of zones	2	2	2, 3	2, 3	3	4	4–5	4–5	4–6	5
Max kw demand on barrel	7.2	7.2	10.5–24.5	15.0–38.5	21.6–50.0	32.5	30.0–71.0	60.0–170.0	75.5–288.0	260.5
Approx. heat-up time, min., from room temp. to 500° F. (for polyethylene specified above)	—	—	—	—	—	—	—	—	—	—
Hp. of: Drive	2	2	7½–15	10–20	20–30	30	—	—	—	—
Motor	—	—	7½–15	10–20	20–30	30	40–75	75–125	100–250	250
Special features of standard units	Special vents and valves available. Prewired control panels. Various dies available.									
Optional features	Valving for intermittent operation. Clamp-type or flange and swing bolt closures. Blower cooling or cooling coils on barrel, screw extractor, electr tation optional. Center-fed throat sections with packing glands optional.									
Approx. floor space (L x W), feet	2 x 4	2 x 4	3½ x 5½ to 8	3½ x 5½ to 8	6 x 7 to 12	7 x 9	6 x 9 to 15	7 x 12½ to 20	8½ x 15 to 25	9 x 22
Approx. delivery time, weeks	4	4	4	6	6	6	6–8	6–8	8–12	20

* Nominal capacity.

Farrel-Birmingham

Manufacturer*										
Extruder name and model no. (if any)	8 x 4½"	6"	13 x 7"	13 x 8½"	8½	10"	12"	12"	15 x 12"	15"
Number of screws	One	One	One	One	One	One	One	One	One	One
Screw: Diameter, inches	8 x 4½f	6	13 x 7f	13 x 8½f	8½	10	12	12	15 x 12f	15
Effective length, inches	80	60	54	54	168	200	144–264	144–264	72	100
Speed range, rpm	70–175	10–100	4–40	4–40	8–80	6–60	8–75	8–75	4–45	4–40
Design type	Hot feed, full-flighted.	Metering or full-flighted.	Hot feed, full-flighted.	Hot feed, full-flighted.	Cold feed, metering.	Cold feed, metering.	Hot feed, full-flighted.	Cold feed, metering.	Hot feed, full-flighted.	Cold feed, metering.
Barrel pressure range, psi	3,000–15,000, depending on specifications.									
L/D ratio, excluding feed opening	16:1	9:1	6:1	5:1	18:1	19:1	9:1–21:1	9:1–21:1	5:1	5:1
Input brake hp	—	—	—	—	—	—	—	—	—	—
Extrusion capacity, lbs./hr., based on polyethylene (20,000 mol. wt., 4.0 melt index, 0.92 sp. gr.) at 500±1° F. with output rate held to ±1%	2,500 max.††	1,000 max.††	2,000 max.††	3,000 max.††	1,500 max.††	2,000 max.††	5,500 max.††	3,000 max.††	5,500 max.††	7,000 max.††
Gear reduction type	Single reduction, double helical unit.	Double reduction, double-helical unit to suit power.								
Thrust carrier: Type	Single or tandem Rollway thrust bearings, depending on speed and power.									

Royle (Cont'd)

20–200	20–200	18–180	18–180	18–180	18–180	18–180	18–180	13–130	10–100	10–100
Metering	Metering	Metering	Metering	Metering	Metering	Meterin	Metering	Metering	Metering	Metering
10,800*	11,000*	14,300*	9,700*	7,800*	10,600*	8,800*	10,500*	8,300*	8,500*	8,900*
27:1	24:1	24:1	24:1	20:1	23:1	18:1	20:1	15:1	14:1	14:1
—	—	—	—	—	—	—	—	—	—	—
50	135	175	450	700	800	1,350	1,800	2,700	4,500	6,500
Worm	Worm	Worm	Worm	Worm	Worm	Opposed helical.	Opposed helical.	Opposed helical.	Opposed helical.	Opposed helical.
Roller bearing.	Roller bearing.	Roller bearing.	Roller bearing.	Roller bearing.	Roller bearing.	Roller bearing.	Roller bearing.	Roller bearing.	Roller bearing.	Roller bearing.
98,000**	110,000	130,000	72,000	37,000	94,000	56,000	90,000	46,000	40,000	56,000

Stainless steel, hard-surface weld.

Steel with removable Xalay liner.

Positive, self-enclosed.

Tubular resistance.	Tubular resistance.	Tubular resistance.	Tubular resistance.	Tubular resistance.	Tubular resistance.	Tubular resistance.	Tubular resistance.	Tubular resistance.	Tubular resistance	Tubular resistance.
Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning
4	5	6	6	6	6	6	6	6	6	6
9	18	27	51	54	61	75	85	108	132	150
30	30	30	30	40	40	40	40	50	50	60
10***	16	22	35	50	70	130	200	320	440	750
10	15	20	30	50	60	125	200	300	400	750

Safety head bolts. Gear and thrust carrier in common housing. Dual voltage control. High-velocity evaporating cooling. Spirod radiant heating

Two-stage extrusion; Vented extrusion; Controlled velocity flow.

4 x 1	5½ x 2	7 x 2	8½ x 2½	9 x 2½	14 x 3	11½ x 4	13 x 4½	14 x 5	16 x 6	20 x 9
—	—	—	—	—	—	—	—	—	—	—

* Based on thrust capacity.
** At 100 rpm. and 5,000 psi. pressure.
*** Drives are interchangeable with various bore sizes where horsepower requirements may differ from those of standard units.

Prodex

175–20	175–24V	250–20	250–24V	350–20	350–24V	450–20	450–24V	600–20	600–24V	800–20	800–24V
One	One	One	One	One	One	One	One	One	One	One	One
1¾	1¾	2½	2½	3½	3½	4½	4½	6	6	8	8
35	42	50	60	70	84	90	104	120	144	160	192
0–218	0–218	0–155	0–155	0–100	0–100	0–68	0–68	0–65	0–65	0–55	0–55
Metering	Metering	Metering	Metering	Metering	Metering	Metering	Metering	Metering	Metering	Metering	Metering
10,000 max.	10,000 max.	10,000 max.	10,000 max.	10,000 max.	10,000 max.	10,000 max.	10,000 max.	10,000 max.	10,000 max.	10,000 max.	10,000 max.
20:1	24:1	20:1	24:1	20:1	24:1	20:1	24:1	20:1	24:1	20:1	24:1
7½–10	7½–10	20	20	40	40	60–75	60–75	125	125	200	200
75	75	180	180	375	375	525	525	1,000	1,000	1,600	1,600
Helical	Helical	Herringbone	Herringbone	Herringbone	Herringbone	Herringbone	Herringbone	Herringbone	Herringbone	Herringbone	Herringbone
Spherical roller.	Spherical roller.	Spherical roller.	Spherical roller.	Spherical roller.	Spherical roller.	Spherical roller.	Spherical roller.	Spherical roller.	Spherical roller.	Spherical roller.	Spherical roller.

Farrel-Birmingham (Cont'd)

Manufacturer*										
Life rating, hrs., at 100 rpm. and 5,000 psi....	Life rating generally based on minimum of 5-year life under maximum operating conditions.									
Materials, base and surfacing, for: Screw.....	Stainless steel, stellite-tipped thread.	4140 ST, Stellite-tipped thread.	35CST, Stellite-tipped thread.	35CST, Stellite-tipped thread.	4140ST, Stellite-tipped thread.	4140ST, Stellite-tipped thread.	4140ST, Stellite-tipped thread.	4140ST, Stellite-tipped thread.	4140ST, Stellite-tipped thread.	4140ST, Stellite-tipped thread.
Feed cylinder.....	Mechanite, cast steel or welded steel, depending on pressure specified, with Xaloy liner.									
Lubricating system.....	Pump and splash.	Pump and splash.	Pump and splash.	Pump and splash.	Pump and splash.	Pump and splash.	Pump and splash.	Pump and splash.	Pump and splash.	Pump and splash.
Heaters: Type.....	Steam, oil or Dowtherm.	Steam, oil or Dowtherm.	Steam, oil or Dowtherm.	Steam, oil or Dowtherm.	Steam, oil or Dowtherm.	Steam, oil or Dowtherm.	Steam, oil or Dowtherm.	Steam, oil or Dowtherm.	Steam, oil or Dowtherm.	Steam, oil or Dowtherm.
Control.....	Manual or automatic.	Manual or automatic.	Manual or automatic.	Manual or automatic.	Manual or automatic.	Manual or automatic.	Manual or automatic.	Manual or automatic.	Manual or automatic.	Manual or automatic.
Number of zones.....	Depend on number of cylinder sections.									
Max. kw. demand on barrel...	—	—	—	—	—	—	—	—	—	—
Approx. heat-up time, min., from room temp. to 500° F. (for polyethylene specified above).....	—	—	—	—	—	—	—	—	—	—
Hp. of: Drive.....	All drives designed for approximately 1.5 to 1 service factor.									
Motor.....	40-75	60-125	40-125	50-125	100-300	125-400	100-400	100-600	100-200	100-200
Special features of standard units.....	All dual-diameter screws designed to take complete batch from Banbury mixer. Standard or vented cylinders can be furnished. Continuous mi									
Optional features.....	Sheet, strand, or underwater pellet die types available. Hydraulic breechblocking, hydraulic or manual "C" clamp, or swing bolt head types avail									
	unit, Dynamatic, Oilgear or American Blower Fluid coupling and A.C. motor available as									
Approx. floor space (L x W), feet.....	6-7/12 x 24-2	4¾ x 12	6½ x 12	6¼ x 10¾	6-7/12 x 26-10	8½ x 26½	7½ x 25 up to 9 x 40	8½ x 17	7½ x 17-10½	
Approx. delivery time, weeks.....	Since machines are generally to customers' specifications, delivery times are 20 weeks and up.									

ǂ Larger size screw is through hopper section, tapering to smaller size just forward of hopper, then continuing straight to head.
ǂǂ Production.

MPM

Manufacturer*				
Extruder name and model no. (if any)...	EF-100-12	EF-150-20	EF-250-20	EF-350-20
Number of screws.....	One	One	One	One
Screw: Diameter, inches.....	1	1½	2½	3½
Effective length, inches.....	12	30	50	70
Speed range, rpm.....	8-80	14-96	7-85	7-85
Design type.....	All types available.			
Barrel pressure range, psi.....	10,000	10,000	10,000	10,000
L/D ratio, excluding feed opening.....	12:1	20:1	20:1	20:1
Input brake hp.....	½	3-5	15-25	20-40
Extrusion capacity, lbs./hr., based on polyethylene (20,000 mol. wt., 4.0 melt index, 0.92 sp. gr.) at 500–4 F. with output rate held to ±1%.....	6-12	30-40	85-135	200-250
Gear reduction type.....	BGW	Morse chain	Herringbone	Herringbone
Thrust carrier: Type.....	Roller thrust.	Roller thrust.	Roller thrust.	Roller thrust.
Life rating, hrs., at 100 rpm. and 5,000 psi....	11,750*	59,400**	215,000ǂ	400,000ǂǂ
Materials, base and surfacing, for: Screw.....	Stainless steel or chrome-plated steel.			
Feed cylinder.....	Xaloy 306	Xaloy 306	Xaloy 306	Xaloy 306
Lubricating system.....	Gravity	Gravity	Gravity	Gravity
Heaters: Type.....	Cast-in, band, or induction types.			
Control.....	Proportioning	Proportioning	Proportioning	Proportioning
Number of zones.....	2	2	4	4
Max. kw. demand on barrel...	1.8	5.2	13	25
Approx. heat-up time, min., from room temp. to 500° F. (for polyethylene specified above).....	—	—		
Hp. of: Drive.....	—	—		
Motor.....	½	3-5		
Special features of standard units.....	Vents, valves, working pr			
Optional features.....	Other extruder sizes avail are 2-, 4½-, 6-, and 8-inc			
Approx. floor space (L x W), feet.....	3 x 2	6 x 2		
Approx. delivery time, weeks.....	—	—		

* Dynamic load rating
** Dynamic load rating
ǂ Dynamic load rating
ǂǂ Dynamic load rating

*Complete manufacturers' names and addresses are as fo
Aetna-Standard Engineering Co., Pittsburgh, Pa.
Davis-Standard, Div. of Franklin Research Corp., Mysti
Frank W. Egan & Co., South Adamsville Rd., Somervill
Electrophysical Engineering Co., Div. of National A
Inc., 930 N. Parker St., Orange, Calif.
Farrel-Birmingham Co., Inc., Ansonia, Conn.
Hartig Engine & Machine Div., Midland-Ross Corp.
Westfield, N. J.
Johnson Machinery Co., 683 Frelinghuysen Ave., Newar
Killion Tool & Mfg. Co., 56 Depot St., Verona, N. J.
Modern Plastic Machinery Corp., 15 Union St., Lodi, N.
National Rubber Machinery Co., 47 W. Exchange St., A
Prodex Corp., King George Post Rd., Fords, N. J.
John Royle & Sons, 10 Essex St., Paterson 3, N. J.
Welding Engineers, Inc., P. O. Box 391, Norristown, Pa.

Prodex (Cont'd)

			83,000	83,000	102,000	102,000	35,000	35,000	28,000	28,000	33,000	23,000	31,000	31,000
	4140ST, Stellite-tipped thread.	4140ST, Stellite-tipped thread.	High-tensile steel base with stellite tips.											
			Xaloy or Xaloy 306.											
od	Pump and splash.	Pump and splash.	Gear pump with filter.											
il m.	Steam, oil or Dowtherm.	Steam, oil or Dowtherm.	Stainless-steel resistance heaters.											
or ic.	Manual or automatic.	Manual or automatic.	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning	Proportioning
			2	2	3	4	4	4	4	4	4	5	6	6
	—	—	6	8	20	25	30	40	45	60	75	90	110	140
	—	—	25	25	25	25	25	25	25	25	25	25	25	25
			12	12	30	30	60	60	90	90	175	175	250	250
0	100-200	200-800	7½-10	7½-10	20	20	40	40	60-175	60-175	125	125	200	200
	Continuous mixing or forcing screws available		Valve	Vent & valve.	Valve	Vent & valve.	Valve	Vent & valve.	Valve	Vent & valve.	Valve	Vent & valve.	Valve	Vent & valve.
			Machines include pressure gages, thermocouples, tachometers and watt meters as standard equipment.											
	lt head types available. D.C. motor available as types of drives.		Stainless-steel screws. Induction heaters.											
7	7½ x 17-10½	10 x 30	3 x 5	3 x 5	3 x 8	3 x 9	3½ x 11	3½ x 13	4 x 13	4 x 15	5 x 15	5 x 20	6 x 22	6 x 24
			4	4	4-8	4-8	4-8	4-8	6-8	6-8	10-12	10-12	12	12
ad.														

	—	—	—
	—	—	—
5	3-5	15-25	20-40

valves, working pressures at 10,000 psi.

xtruder sizes available, both vented and unvented, 4½-, 6-, and 8-inch models.

2	6 x 2	8 x 4	10 x 4
-	—	—	—

amic load rating at 4,000 hrs. and 5,000 psi.
amic load rating at 75,000 hrs. and 5,000 psi.
amic load rating at 165,000 hrs. and 5,000 psi.
amic load rating at 182,000 hrs. and 5,000 psi.

dresses are as follows:
urgh, Pa.
h Corp., Mystic, Conn.
Rd., Somerville, N. J.
of National Automotive Fibres,
Conn.
and-Ross Corp., P. O. Box 531,
en Ave., Newark 5, N. J.
Verona, N. J.
on St., Lodi, N. J.
Exchange St., Akron 8, O.
ords, N. J.
n 3, N. J.
Norristown, Pa.

What a Plastics Engineer Should Look For When Planning to Buy an Extrusion Machine
(*Cont'd. from page 818*)

regrinding, and blending of materials.

Quite often, secondary operations are performed on the extruded part. These include buffing, printing, painting, punching, etc. The engineer should also consider the desirability of a pre-finishing "inventory area" for storage of extruded parts until such time that they may be finished. Packaging the finished articles and, finally, shipping of the package are considerations that must not be overlooked. By careful planning prior to machine delivery, time and money can often be saved.

Financing, reselling used equipment, and trade-in values are items that must be met and solved. These considerations are most important, but should be considered secondary to the principal specifications.

Machine delivery times will vary with the equipment manufacturer. When asking for bids on machinery, the engineer should obtain approximate delivery times. This will allow him to plan for the installation and time his operations so that it can be installed properly immediately upon receipt of the equipment.

Installation costs will vary, depending on local labor and material costs. The extrusion machine builder can recommend foundation sizes, power requirements, and other information pertinent to the actual installation. From these data, the engineer can calculate in advance the approximate installation cost. Some machine builders offer the services of a technical advisor durng the installation of their equipment.

Careful advanced planning on the part of the plastics engineer will pay dividends in future operation of the extruder. It is suggested that the engineer discuss the planning with members of his own firm, and the machine builders, in order to arrive at the best solution for his problems.

—THE END

Vacuum-Forming with Epoxy Resin Molds

Sections of hardened plaster are cut and assembled into a mold.

A female master mold is cast in plaster.

Vinyl replicas are set in a wooden frame and reinforced with plaster splash.

Epoxy is poured into the frame. Note the pins for vacuum holes and copper tubing for cooling.

Formed sheets are cut into smaller units in preparation for die cutting.

VACUUM-FORMING is an industry which adapts itself very well to the use of epoxy molds. These molds have the dimensional stability required for long production runs, are sufficiently strong and durable, yet can be made easily and economically at the vacuum-former's plant.

Chanal Plastics, Inc., Rego Park, N. Y., uses epoxy molds for the production of styrene "planters"—containers for flowers or plants. A sculptor models a mold in plaster, fluting the sides not only as a design feature, but for the rigidity it provides. A "female" plaster mold is cast from this original, and becomes the master mold.

The plaster master is placed on a vacuum-forming unit or a sample machine to "draw" an exact replica in vinyl. This material is used because of its low-shrinkage qualities. Wire mesh is placed on the bottom of the plaster cast to allow air escape through the vacuum holes which have been drilled in the bottom of the casting.

The vinyl draw now becomes the model from which the epoxy mold is cast. A wooden frame is built around the draw, which is reinforced with plaster splash to keep it from losing its shape as the mold is poured. Pins are set in the draw wherever vacuum air holes will be required, and copper tubing is set in the frame for the water-cooling system. Although water cooling is a costly procedure, it pays for itself when long runs are scheduled.

The epoxy resin is mixed and poured into the frame. Chanal uses epoxies supplied by Smooth-On Mfg. Co., since that firm's materials can be poured to a depth of several inches at one time. Previous formulations used by Chanal could not be poured faster than ½-inch at a time. Twelve molds are made, as that number can be accommodated on the vacuum bed. The molds are allowed to set overnight after which they are oven-cured for eight hours. On removal from the oven, the plaster splash is broken and the vent pins are removed. The molds are now ready for use.

For the actual forming, a sheet of 0.080-inch styrene is placed between the clamp and drape, the start button is pressed, and the heater moves forward. Temperatures used for this application are in the range of 900-1,000° F. When the heater returns to its original position, the drape drops the hot plastic sheet onto the wooden molds, and the plug assists come down to distribute the material evenly between the molds. When they reach bottom, the vacuum begins and, as the plugs rise, the blowers go on to cool the plastic from above. Simultaneously, the water is coursing through the copper tubing in the molds to cool it from beneath. Cycle time is approximately 60 seconds.

On removal of the formed sheet, steel-rule dies are used to cut same into smaller sections. These parts are conveyed to an operator who separates the individual planters from the die-cut scrap and packs the finished product. Since Chanal makes its own dies, the entire operation is a captive one and any inaccuracies can be corrected quickly on the spot. —THE END

g. Co.,
epth of
ns used
inch at
per can
lds are
oven-
ven, the
moved.

styrene
button
empera-
nge of
original
nto the
to dis-
. When
he plugs
above.
he cop-
n. Cycle

dies are
arts are
dividual
finished
e entire
ties can

THE END

OLOGY

R. S. JACKSON, *Chief Engr.*,
The Glastic Corp.,
Cleveland, Ohio

Reliable Properties

Can Be Guaranteed

Statistical control methods reduce costs, make efforts more productive, and accelerate product and process improvements in both large and small plants.

WEBSTER defines cantankerous as: "exhibiting ill nature; perverse; contentious." Most of us in the reinforced plastics industry have had many occasions to feel that such adjectives admirably describe the materials with which we must work. At the same time, we strive to tame these seemingly wild and obtuse elements so that our customers will not feel that those same adjectives, not to mention further epithets, apply to our own products!

This paper outlines some of the techniques that my company has used in its efforts to manufacture reinforced-plastic products for the heavy electrical industry of uniformly high quality and at commercial prices, without incurring excessive costs through over-design, over-inspection, or high reject rates. The methods and techniques discussed here are not new; we have been pleasantly surprised to learn how many techniques seem ready-made to help us solve our problems of improving quality and, at the same time, reducing costs. It is hoped that others will find useful the results of our searching for better ways of solving problems.

We all have heard it said that "quality must be built into a product—it cannot be inspected in." We all nod our heads in agreement; it is only when we encounter the economic realities of the market that we find this sage advice somewhat difficult to apply. In short, we find that we are not supplied with unlimited funds with which to build in this quality. Without question, it is in the wise design of product and process, the combining of the various elements of production, both understood and unknown, that the engineer encounters one of the greatest challenges to his skill and imagination. It is in this area that many orgnizations in our field find themselves reduced to "cut and try." How many times have our experiments indicated that we might reliably expect a certain result, only to find that we have produced a quantity of "surprise product." Fortunately, there are powerful tools available to help cope with such problems; this paper will be concerned primarily with these problems of "building-in" the required quality economically.

Normal Distribution Curve

When we start to "build-in" quality, we rapidly find that one of the major problems is that quality usually costs money, particularly in the field of materials, and that our customers have limited pocketbooks. This, as we all know, requires that we consider carefully what the customer wants in the way of quality and relate that desire to our available materials and processes. We

must shave our costs as far as we can without endangering our ability to guarantee the desired quality level. In fact, it is primarily the skill with which we perform this function that determines the success of our products in the market-place and the financial success of our enterprise.

The key to reliable quality at economical costs is an understanding of the nature of the inherent variability of our materials, processes, and products. We are accustomed to think of the impact strength of the molding material, the flexural strength of the laminate, and the cantilever strength of the insulator. In reality, however, there are many individual values of each property, all grouped in the general vicinity of the specification. For some reason, the fact that there will be variation in the product escapes the casual observer. Nevertheless, rather than dealing with one value, we must concern ourselves with a spread of values.

The concept of a "normal" amount of variability is so important that we will take a moment to discuss its nature. That it is important is not theory useful only for large organizations. The ideas and techniques that derive from an understanding of such variability are of immediate and important value for large and small organizations alike, for both long and short runs. As a matter of fact, it is in the application to short (but repetitive) runs that control charts, for example, provide some of their greatest rewards.

Variability generally follows a pattern of "normal frequency distribution." Here, a large number of factors independently cause variations of equal magnitude. The result is a distribution of values, as shown in Figure 1. Values near the average ($\bar{\bar{X}}$) occur most frequently. As we depart from the average, values are observed less and less frequently. This distribution of values is typical of a great number of properties, such as tensile strength, impact strength, dielectric strength, etc.

There are two important characteristics of any such curve; the average value ($\bar{\bar{X}}$) and the range or spread of values. A measure of the spread of values is the "standard deviation," usually called "sigma," that is defined as the root-mean-square deviation of all values from ($\bar{\bar{X}}$). It is important to note that for normal curves, 99.74% of all values lies in the range of ±3 sigma from the average. It is equally important to note that a range of only ±2 sigma will include 95% of the data.

In other words, a relatively small increase in reliability, from 95% to 99.7%, requires either a large (50%) increase in allowable tolerance, a corresponding improvement in process (not always possible or economical), or a significant increase in cost so as to raise the process average. This is a measure of the high cost of requiring that all individual values be above specification. This high cost of trying to be perfect is the reason that a policy on desired quality level definitely is a required management decision.

Our major concern in the attempt to achieve quality economically is with the relationship between this spread of values and the required specifications or tolerances. If a process has too large a sigma to meet the required tolerances (see Figure 2), exhorbitant expenses will be incurred. A good rule-of-thumb is that the 3-sigma limits should occupy 75% of the tolerance range if all the individual values are to be within tolerance. When a process has a lower 2-sigma limit (97%) that is too far above the specification value, cost reductions can be made while still retaining the desired reliability.

Figure 3 gives an outline of the general path that most new products or processes take on their way to becoming commercial products. The generally recognized phases are research, development, pilot or semi-works, and production. Each phase, however brief or informal, has an important bearing on the economic results of the final product, and is where quality is "built-in!" The question is not "Shall we go through these phases?" for we always do go through each phase, sometimes in a haphazard way. The real question is "How can we get the most for our dollar in each phase?" The inherent variability of the product makes the work of relating cause and effect very difficult during the development and pilot stages. Skill is required to separate random variation from the effects of experimental variations. The same random variation makes process control difficult during the production phase.

Use of Statistical Control

Experimental Phase

All new products require experimentation, and

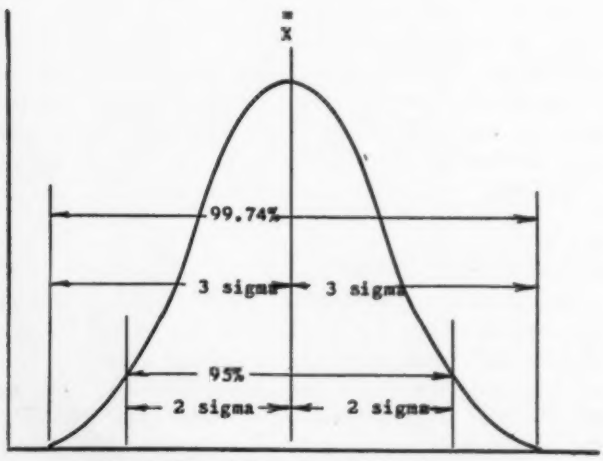


Fig. 1. Normal frequency distribution curve.

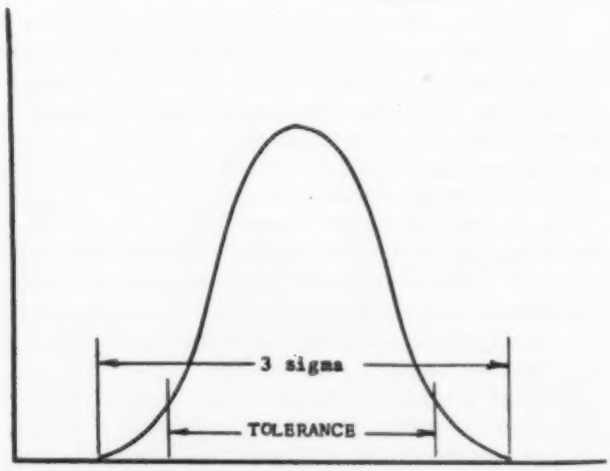


Fig. 2. Frequency distribution curve showing too large a spread.

most production difficulties result in experimentation. Whether the required amount of experimentation is small ("Let's try a little higher mold temperature") or large ("Let's build a fiber-glass moon rocket") certain requirements must be met; (1) an experiment must be designed in such a way that it will yield the desired information; and (2) the results of the experimentation must be analyzed to obtain the desired information. We might say that is obvious enough; but is it?

Haven't we all tried the classical method of holding everything constant except one factor that we vary, observe the result, then vary other factors in the same manner, only to be surprised that two and two apparently do not total four when we use the results of our experimentation to predict optimum operating conditions. The classic example is to observe that a change from 1% to 2% catalyst increases the flexural strength by 10%, and that a change from 210° F. to 250° F. in mold temperature increases the flexural strength by 15%, only to find that 2% catalyst and 250° F. in combination actually reduces the flexural strength.

A frequent reaction to this situation is that "something must have gone wrong." Not necessarily; this merely is an indication of the interaction between catalyst concentration and cure temperature as they affect the physical properties of the cured laminate. This is the reason that the "try a little of this" approach is of small value in any problems, but the most obvious.

You might say that "we do not have the time for fancy experiments." Perhaps this is true, but we were surprised to find that the same amount of work we were applying on a hit-or-miss basis yielded far greater returns when applied with modern experimental techniques. The essential feature of modern experiment design is that several factors are investigated simultaneouly. This enables the experimenter to cope with the problems of interaction and reduce the amount of experimentation required. Of the several techniques available (1, 2),* we will mention only two; the "factorial experiment," and the so-called "Latin-Square."

The factorial experiment will yield the greater amount of information, but it requires that experiments be conducted that include each factor at each level it is desired to investigate. This requires many experiments if a large number of factors at several levels are to be considered. Normally, it is used when the important variables are few and the proper ranges for each have been established. If the materials or processes are less well understood, then the required amount of work may be greatly reduced through the use of the Latin Square experimental design. This technique will give a good initial idea of the nature of the problem with a minimum of experimentation.

Figure 4a illustrates a 2 x 2 Latin Square that can be used to examine the effects of three variables, each at two levels. The work required is one-half that of the complete factorial. Each block in the square represents one experiment. The effect of Variable "A" on the result is obtained by averaging the horizontal columns and comparing them. Similarly, the effect of Variable "B" may be observed by averaging the vertical columns and comparing "B-High" with "B-Low." The effect of Variable "C" is obtained by averaging and comparing the squares diagonally. The Latin Square type of experiment can handle three factors at three levels each in the 3 x 3 square illustrated in Figure 4b. It is important to note that the Latin Square will not discern the effects of interaction.

When the broad outlines of the problem have been defined through the use of Latin Square experiments, the appropriate squares can be expanded into two level factorials. These two level factorial experiments are used to examine the problem more closely, and can be used to discern the effects of interaction. Figure 5 is an outline of a simple two-level factorial involving three factors. If required, the two-level factorials can be expanded into multiple-level designs.

The general approach, then, is:

(1). List the known variables in the estimated order of their importance, and group together those factors that are likely to interact.

(2). Conduct Latin Square experiments to obtain a preliminary idea of the proper area in which to be working. (This step may be unnecessary in modifications of well-understood processes.)

(3). Expand the appropriate Latin Squares into two-level factorials.

(4). If necessary, expand the two-level factorials into intermediate level factorials.

It is of the utmost importance that the analysis of data be conducted concurrently with the experimental work (even though final conclusions cannot be reached) in order that unnecessary work be eliminated and that profitable lines of experimentation be recognized quickly. The analysis of data requires that we have some means of determining whether or not the differences we observe between sets of data are significant.

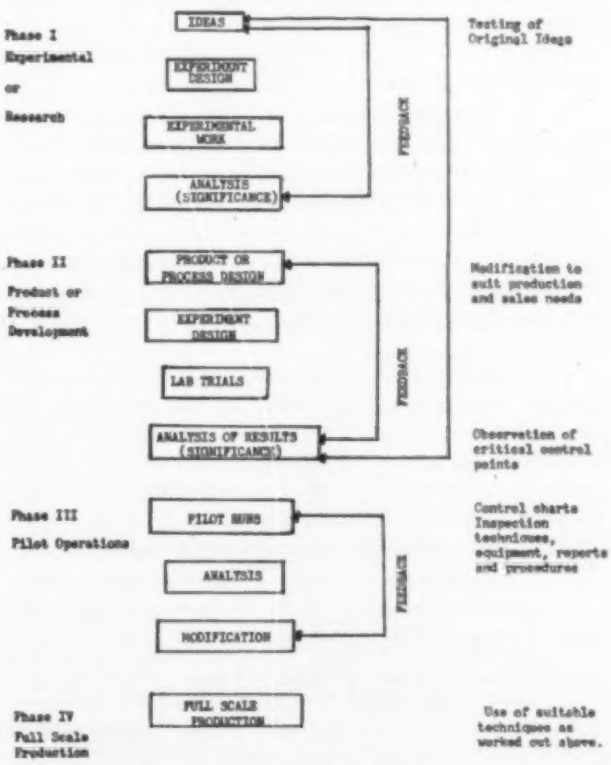


Fig. 3. Flow chart for quality control of a product or process.

*Numbers in parenthesis refer to bibliography at end of article.

In addition, we want to know if those differences could have occurred by chance. Of course, this is no problem if the data do not overlap. For example, if one set of values runs from 20,000 to 24,000 psi., and the second set runs from 25,000 to 29,000 psi., there is little doubt that a significant difference exists between the two sets.

A more usual case, however, dealt with two sets of data that were obtained in an experiment designed to observe the difference between two different binders on random fiber glass mats as they affect laminate flexural strengths. The average of one set was 8½% higher than the average of the second, inviting the conclusion that a significant difference between the binders existed. A statistical analysis of the data, however, reveals that there was better than a 20% chance that there was no difference between the two binders, and that random variation could have caused the observed difference even if there had been no change in binder. Since 80% reliability hardly is enough on which to base future work, the experiment had to be repeated to secure greater reliability.

The required "significance calculation" is neither difficult nor time consuming, and the time required to do a proper job of analysing the data is certainly a small fraction of the time required to obtain the data. A common method is known as Student's "t" Test; details of the test may be found in most Bibliography references at the end of this paper. Student's "t" test can be used to compare an average with a standard or specification value, and also may be used to compare one average with another. If it is desired to compare the spread of value or dispersion of one set of data with that of a second set, a method known as the "F" test is of value (1, 4). Wise use of these simple calculations can prevent much misinterpretation of experimental results.

Development Phase

In the development phase, the product or process is tailored to meet certain specific requirements in the most economical manner. If this is to be done satisfactorily from all points of view, the range of experimental values must be gotten far enough above specification that the shop will not be always in trouble, yet the values must be kept sufficiently close to specification that the material and labor input are at economical levels.

This requires that we be able to predict in advance (usually from a relatively small amount of data) what all the observed values are apt to be throughout the manufacturing history of the job. Actually, we should reach no important conclusions regarding our ability to meet a given specification without at least 10 sets of data. Since reliability increases as the square root of the number of observations, this means that practical reliability increases very rapidly as we approach 10. At that level, we reach the point of diminishing returns.

	B-High	B-Low
	C-High	C-Low	C-High	C-Low
A-High	C-High	C-Low		
A-Low	C-Low	C-High		

	B-High	B-Med	B-Low
A-High	C-High	C-Med	C-Low
A-Med	C-Med	C-Low	C-High
A-Low	C-Low	C-High	C-Med

Fig. 4. Factorial control by (a) two-by-two and (b) three-by-three Latin Squares.

Other important questions also must be raised before deciding that a design is satisfactory for production, and the skill with which it is answered has an important bearing on the ultimate success of the product. This important question is "Will the production equipment and organization produce better results than were obtained in the laboratory?" This frequently is the case in continuous processes and with larger batches where variations sometimes can be averaged. The question also can be put as "Will the production unit be unable to do as well as was possible under the controlled conditions of the laboratory?" Also, what factor of safety will be found economical in the plans? These intangibles must be weighed in the balance before we commit the design to production.

Pilot Operations

The purpose of the pilot operation is to provide an opportunity to shake the "bugs" out of product and process in order to obtain a working operation to release for production. Pilot runs are made and analyzed, and any necessary adjustments are made to improve the processing. It is highly desirable to have some means of stating, in language that everyone can understand readily, how the product quality compares with the required specifications.

Among the most useful devices for doing this are Shewhart's control charts for averages and ranges (the well known $\bar{x}$ and $\bar{R}$ charts). These not only have the advantages of expressing any given variable in terms of its average value and its spread of values, but also the advantage of being directly applicable to use for control of quality during the production phase. During the pilot runs, critical variables may be examined to determine if they are in control, and whether they bear satisfactory relationships to the specification values. Figure 6 illustrates the use of such charts.

Each point on the chart represents an average of five tensile test values taken from successive runs of an insulator molding. It is readily apparent that a considerable variation in tensile strength exists, and a certain amount of variation can be expected to occur from so-called random or chance causes. The "upper control limit" and "lower control limit" marked on the charts show the boundaries of variation considered reasonable to attribute to chance causes; such limits are defined by a simple statistical calculation (1, 4).

If the variation of values stays within the control

	B-High		B-Low	
	C-High	C-Low	C-High	C-Low
A-High				
A-Low				

Fig. 5. Simple two-level Latin Square for factorial control.

limits, the process may be said to be in control and it can be expected that future test results can be predicted from a three-sigma calculation. If, however, points fall outside of the control limits, as at "A" and "B," the process may be out of control because some influence other than chance cause is operative. This means that something must be done to bring the process back into control.

It should be noted that the lower control limit line in Figure 6 (Upper) is actually lower than the specification. If this process were released for production, the shop continually would be in trouble because the process is not capable of consistently producing the desired result. Note, also, that a general downward trend becomes apparent in the latter part of the chart. This is a clear indication that the process is deteriorating for some reason or another. The process is out of control and needs corrective action. The value of such a chart, both in the pilot operation and in full production, can be seen readily.

In the case of the pilot plant, the chart can be used to observe graphically the suitability of the process for production. In production, the control chart can be used to control the production, and also is of great value in giving advance warning of potential trouble [before any large amount of scrap is produced. Incidentally, the time required to maintain such a control chart is generally offset by the reduced amount of inspection it allows when used properly. Sampling inspection, frequently a small percentage, is sufficient to check the quality of a process running under statistical control.

During the pilot runs, another important step toward insuring quality should be taken. It is during this phase that the critical parts of the process can be identified, and the properties most difficult to control can be noted. This information is of vital interest to the quality control organization to assist in setting up control points and inspection procedures. In this way, much unnecessary inspection and unnecessarily high losses can be eliminated.

Full Production

During the production phase, the control charts take on additional value. They not only are powerful tools for controlling production, but also are useful for spotting cost-saving opportunities. Figure 6 (Lower) is a control chart for the flexural strength of a commercial laminate, and indicates that the product is in control and comfortably above specification. Too comfortably, in fact. Examination of the chart indicates that the material input could be reduced by some 15% and still have a satisfactory factor of safety above the specification. Incidentally, in this case, only one or two samples from each run are required to be sure that the desired quality level is being produced.

Figure 7 shows an example of a control chart for the scrap rate on a job that seemed to be troublesome. The scrap rate was quite low at times, yet high scrap rates occurred at other times. A control chart was instituted and the methods engineer observed the process for possible error or malfunction every time the scrap rate climbed. Since none could be observed, it was decided that the basic molding method was faulty.

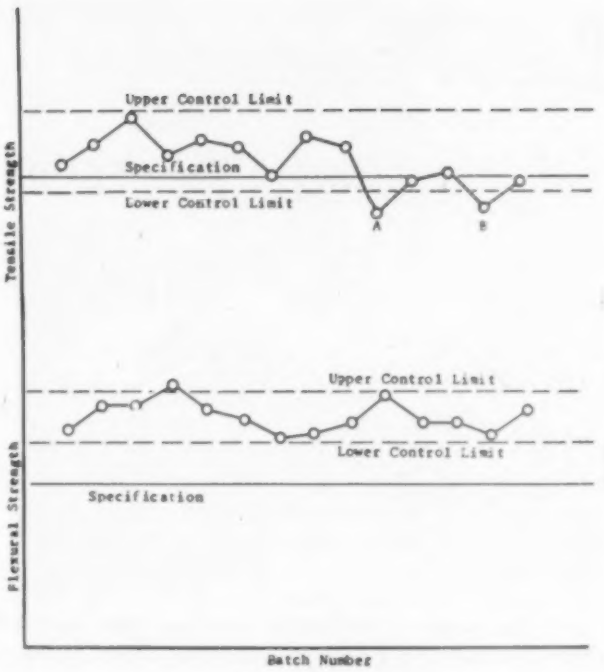


Fig. 6. Control charts for pilot-plant process control. Upper chart shows need for process improvement; lower chart shows process in control and possible cost savings.

The method was changed and the average scrap rate fell from 8.8 to 2.2%.

Many statistical techniques for increasing the degree of process control while, at the same time, reducing the amount of inspection are available. Sampling plans, control charts for attributes, control charts for variables, and tolerance analysis all have their proper place in the molding plant. When applied properly, the rewards are great for the effort expended, and no shop is too large or too small to make use of modern quality control techniques. A single operator running a single machine on a single part would do well to keep a control chart on any critical dimension to make sure that he actually does not make poorer quality by over-adjusting his machine and trying too hard to meet specifications that his process is not capable of meeting.

Conclusions

The problem of guaranteeing reliable properties is a broad one. The emphasis of this paper has been heavily

(*Continued on page 837*)

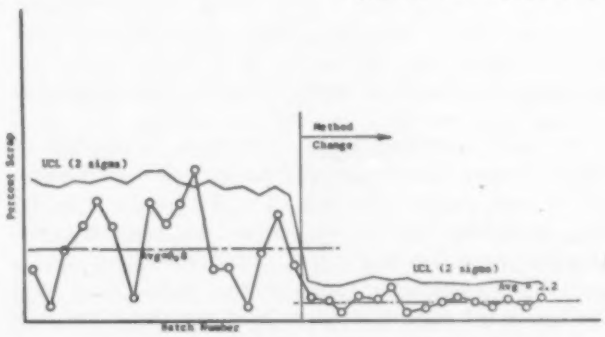


Fig. 7. Process control chart for scrap rate showing: (left) original process; and (right) after a change in methods to reduce scrap rate.

PLASTICS TECHNOLOGY

EXPLORING FABRICATION TECHNIQUES

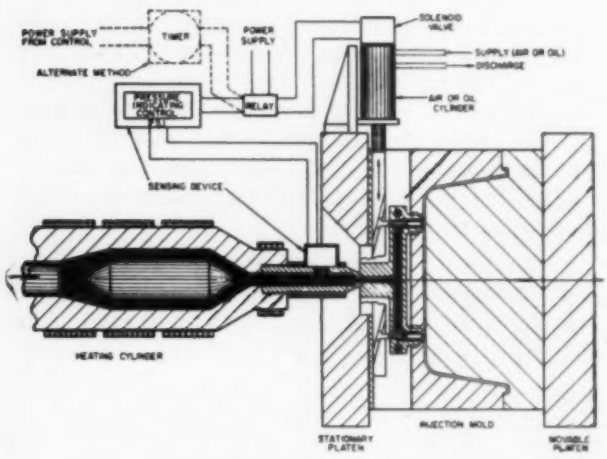
By: L. J. ZUKOR, *Engineering Editor*

Hot Runners . . .

. . . in injection molding are being used very successfully by molders for such high production items as fruit baskets and place mats, especially where a filigree or a lace-like pattern is used. Proponents of this system claim they can obtain faster cycles with less scrap formation.

It is usual, with this system, to take from the mold a part that requires no further finishing. The careful design of restrictive gating will produce almost imperceptable sprues. The remaining dimple, if any, could conceivably be included as part of the decorative pattern.

Operators using hot runners have sometimes experienced difficulty when an interruption has occurred in the cycling of the machine. Such an interruption could cause the material to "freeze" at the gating orifice, and entail a period of shut-down in order to clear the hardened slugs of material from the gates. A method of valving (see our June issue, p. 541) now exists that completely eliminates this difficulty.



Schematic view of hot-runner, multi-valve gate mold.*

Another stumbling block has been the matter of getting proper distribution of heat into the metal forming the hot runner channels. The Edwin L. Wiegand Co., manufacturers of Chromalox heating elements, offer the suggestion that a 35%, 30%, 35% heat pattern across the rectangular area of the metal is a good average arrangement. Higher heat transfer rates can be obtained by the proper choice of metals, ie., the hot-runner channels could be made from stainless steel tubing embedded in an aluminum or bronze casting. The casting then could be machined to receive either strip or tubular heaters in the pattern suggested.

Heat control is generally considered to be critical since the runner must keep the resin in a completely plasticized condition through to the mold cavity. Toward this end, a proportioning-type thermistor controller (see our June issue, p. 562) is well adapted to control the heating of a hot runner assembly.

Still other factors bearing directly on whether or not this system is successful are: a constant melt index of material,—since a slight change in M.I. is reflected in short shots or flashing that in turn, would require readjustments of other portions of the machine; and proper draw-off from the mold,—the latter is governed by all the aspects of mold cooling peculiar to injection molding practices.

*Diagram courtesy: W. R. Grace & Co.

•

Cast Polyethylene Film . . .

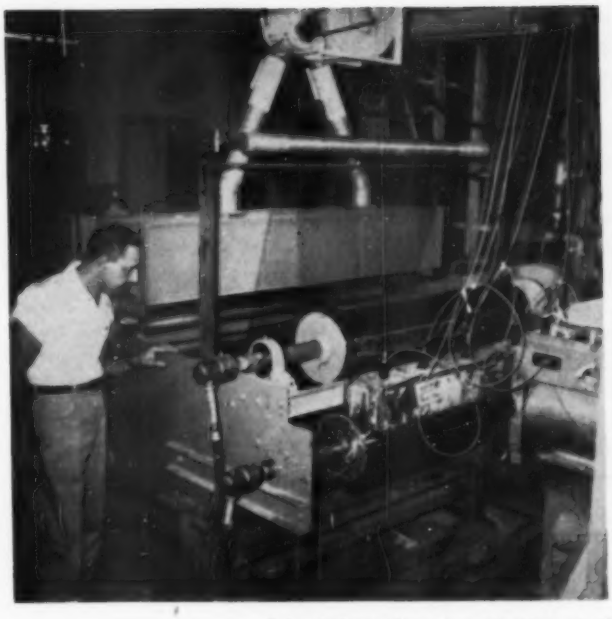
. . . is rapidly capturing the packaging market. Several convertors throughout the nation have commenced production of films in widths up to 100 inches and in thicknesses ranging from 0.2 mils to 10 mils.

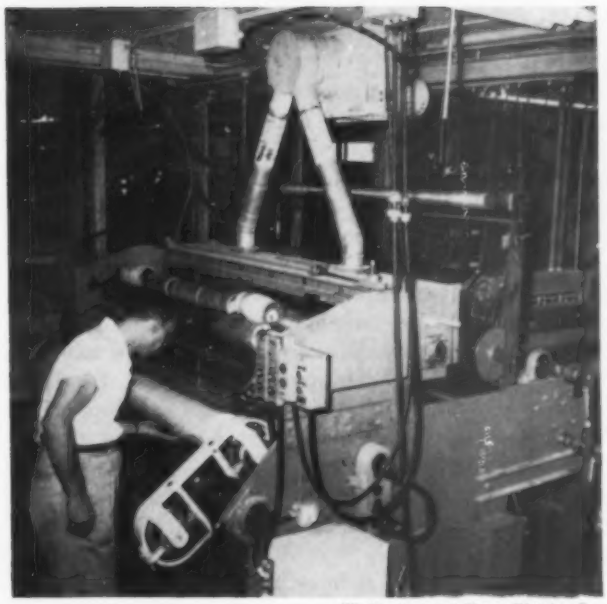
A distinct advantage which this material offers to the packaging field is that it is considerably less expensive than cellophane or polyvinylidene (Saran), yet offers comparable clarity, gloss, and all around protection.

Cast film is produced using conventional extrusion equipment. In the process, polyethylene film is extruded from the die onto a highly polished, water cooled roll. This casting step enhances the optical qualities of the thin film, while at the same time, it imparts a fast chill to harden and fix the gage thickness.

Dies used in casting are of the "T"—type, usually turned so that they extrude downward. The manifold, slot, and lands of the die must be highly polished to yield a smooth film surface and an even web thickness across the width of the film. Any slight irregularity or chink in the die will produce striations and weak spots in the film.

From the chill roll, the web is usually drawn over a doctor roll and then through the pinch rolls. The draw-down rate of the film is controlled by the speed of the pinch rolls, thus determining the gage thickness of the film. The take-up portion of the machine usually contains film spreading devices (this is necessary particularly with film under three mils in thickness) and, if required, a slitter mechanism is included just forward of the take-up reel. The Mt. Hope Roller Company





Photos courtesy: Texas Plastics, Inc.

Polyethylene film in production at the Elsa, Texas, plant of Texas Plastics, Inc.

offers to any equipment manufacturer a patented spreader roll that has proved itself adaptable to this process.

The linear velocity of the extrusion exiting from the die is entirely dependent upon the melt temperature required for the material. This (for any given thickness of finished material) sets up known constants in the differential speeds of the driven rolls so that it is entirely feasible to have automatic servo controls on the machine to keep the web thickness constant.

The speed of the extrusion screw, more than any other variable, controls the machine output. In general, higher screw speeds perform a better compounding action and tend to increase the internal heat through greater friction. Barrel temperatures for flat film polyethylene extrusion range upwards from about 200° F. in the section just forward of the hopper to about 500° F. in the extreme forward section of the barrel. Some manufacturers use a narrower temperature differential between the rear and front ends of the barrel.

In a continuous operation, especially where high heats and high output speeds are encountered, it is desirable that the barrel consists of the best available material. This would be a steel alloy that is resistant to both heat and abrasion.

A heavy screen pack is usually recommended to increase film quality still further. The screen pack helps control back pressure in the extruder, thereby increasing the compounding action. This, in turn, increases the melt temperature. The usual screen pack consists of a number of elements of a 100 mesh screening laid up as required.

—THE END

Reliable Properties Can Be Guaranteed

(*Cont'd. from page 835*)

in the field of building-in the quality. We believe that this is the most important single approach to securing the desired quality level. Even here, we have been able to do little more than point out some of the techniques available to cope with the great amount of variability and interaction between variables that still are inherent in our materials and processes.

The techniques and the mathematics involved are relatively simple, and engineers should be familiar with them. To fail to understand the nature of random variation and the implication of "normal distributions" is to fail to understand the nature of the physical phenomena with which we are dealing. If these techniques are wisely applied, more will be accomplished, and with much less work, than can be done otherwise. Even the highly intuitive experimenter can become far more productive through judicious use of the available statistical tools.

The great value of the statistical approach is that we have simple, adequate language to describe the magnitudes and nature of the variations with which we deal. We also have simple calculations available that make possible accurate comparisons of variable quantities. In addition, the statistical techniques make possible the handling of experiments involving the interactions of several variables at one time, thus leading to a truer understanding of the nature of our materials and processes in less time than otherwise would be possible.

In our case, these techniques have led to cost reductions that repay many times over the small cost of employing them. Our product improvement activities have been accelerated greatly, and our development efforts have been more productive. We hope that every plastics engineer not already doing so will put these ideas to work for him with the same good results.

Much has been said and written on the various mathematical, mechanistic, and systems techniques that can be applied advantageously to the problems of securing the desired quality level. None of these can be truly effective without the wholehearted desire for quality on the part of all the participants in the produc-

(*Continued on page 838*)

Health Safety of Plastics

(*Cont'd. from page 814*)

In the sequence of events that has been developed for introducing a plastic intended for food contact application, the fabricator receives raw materials from the basic supplier, and, in turn, produces the finished film, molded container, extruded pipe, or other product. The fabricator who is careful to use only those materials recommended as suitable for specific applications, is adequately equipped to answer questions that he may receive concerning the safety of his products for use. If changes or additions are made in the material supplied by the resin manufacturer, however, the fabricator must fulfill his own moral and legal responsibilities. He may obtain information from suppliers of the individual ingredients, by contact with the appropriate regulatory agency, or he must select his addition agent from one of the published lists of suitable materials (2,3,4,5,6,7).

A word of caution is in order concerning the use of materials from such lists. Although excellent guides in a development of a new plastic material, it should be realized that these lists are compiled on the basis of information that may have been presented to the Food and Drug Administration as part of a specific formulation. Some ingredients are acceptable only for the packaging of certain types of foods (high water content, for example), while others are limited as to quantity. In essence, the appearance of a chemical name on a published "approved" list does not constitute complete freedom to use any one ingredient, in any formulation, and in any amount.

Conclusions

In summary, the following points, shown in Figure 1, are emphasized:

(1). The manufacturer of a plastic material recommended for specific use in food packaging or housewares, or the fabricator who develops his own formulation, is fulfilling both a moral and legal obligation in determining the suitability from the public health standpoint for the use of his product in contact with foods.

(2). Toxicity is a matter of degree, and only is one of the factors involved in the safety evaluation. "Extraction" is equally important.

(3). The decision as to public health safety must be based on the sound judgment of scientifically-trained personnel that is experienced in such matters.

(4). The manufacturer, having satisfied himself that a plastic is suitable for food packaging and housewares, may present his data to appropriate state or federal agencies concerned with the protection of the public food supplies.

(5). The fabricator should be careful to use only those materials recommended by the manufacturer or material supplier as suitable for specific applications.

(6). Problems in promoting new products sometimes appear formidable. An understanding of basic considerations and the cooperation of the manufacturer, government agency, and fabricator promise new, better, safe plastics for food packaging and housewares.

Bibliography

(1). "Principles and Procedures for Evaluating the Safety of Intentional Chemical Additives in Foods." Pamphlet published by Food Protection Committee, Food and Nutrition Board, National Research Council, Washington 25, D.C. (Nov. 1954; reprinted Jan. 1957).
(2). Lehman, A. J., "Chemicals in Foods: A Report of the Association of Food and Drug Officials on Current Developments," **Quart. Bull. Assn. Food & Drug Officials of U. S.**, 15, 82-89 (1951).
(3). Lehman, A. J., "Plastic Packaging Materials." **Ibid**, 18, 129-134 (1954).
(4). Lehman, A. J., and Patterson, W. J., "FDA Acceptance Criteria." **Modern Packaging**, 27, 5, 115 (Jan. 1955).
(5). Lehman, A. J., "Food Packaging." **Quart. Bull. Assn. Food & Drug Officials of U. S.**, 20, 159-168 (1956).
(6). Wilson, R. H., and McCormick, W. E., "Toxicology of Plastics and Rubber," **Indust. Med. & Surg.**, 23, 479-486 (1954).
(7). Oser, B. L., "Evaluating Safety of Chemicals in Packaging Materials." **Food Eng.**, 27, 57 (April 1955).

—THE END

Reliable Properties Can Be Guaranteed

(*Cont'd. from page 837*)

tive process. As a matter of fact, it can be argued that the main contribution of many of these techniques is to help secure the desired state of mind on the part of the participants. A sincere desire for quality will outweigh any single technique, particularly in smaller plants.

Bibliography

(1). W. L. Gore, "Statistical Methods for Chemical Experimentation," Interscience Publishers, Inc., New York, N. Y. (1952).
(2). "The Design and Analysis of Industrial Experiments," Edited by O. L. Davies, Hafner Publishers Inc., New York, N. Y. (1954).
(3). E. L. Grant, "Statistical Quality Control," McGraw-Hill Book Co., Inc., New York, N. Y. (1952).
(4). "Quality Control for Plastics Engineers." Edited by L. M. Debing, Rheinhold Publishing Corp., New York, N. Y. (1957).

—THE END

Research: The Key to the Plastics Crisis

(*Cont'd. from page 816*)

primary function of the independent laboratory.

The key to the plastic crisis, therefore, is research handled by a competent group of scientists. The combined efforts of two teams, the company's and the independent laboratory's, working together will produce amazing results, as proved by past experience. Not only may new products or processes be developed by such team-work, but the research may open up new ideas and avenues of thought that can result in unexpected gains. No progressive plastics manufacturer or user can afford to overlook the independent research laboratory when a real problem arises.

—THE END

Edited by:
ERNEST J. CSASZAR, *Sales Manager*
Newark Die Hobbing & Casting Co.
Newark, New Jersey

Moldmaking & Tooling

Standardization of Ideas—The SPI Moldmakers Division.

IN my association with the moldmaking industry, I have heard a good many questions asked to which there were widely varying answers. There is no doubt that those sharing these diverged opinions were equally sincere, based on their own particular experiences.

There is a segment of the Society of the Plastics Industry's Moldmakers' Division. This Division operates on a national basis as do the other divisions of SPI. The Division is managed by a Chairman, Vice-Chairman, Policy Committee, and Secretary. The Secretary is a staff member of the SPI, and the Chairman is a director.

As part of the Moldmakers' Division, there are Chapters, some already set up, and some now being organized, in various principal centers in the country. These Chapters operating on a local level enhance the value of the Division with members who otherwise would find it difficult to travel the longer distances to the National meetings. The various committees in the Moldmakers' Division are working, or have published data, on projects involving not only all of the above questions but, of course, many more.

In its operation, projects for possible committee action are suggested to the members of the Division at National Meetings by the Policy Committee. When the membership, by vote, decides a project is worthy of further action, a committee is appointed to work out the details of the project. Considerable discussion by the Division members accompanies the committee work of these projects so that, when the final data is compiled, it represents, not only the results of the few who actually worked up the information, but also the thinking and ideas of individuals representing the industry from different geographical locations, as well as from different viewpoints.

Once compiled, the data is published for distribution to the industry through the SPI. This information is usually compiled in a general or suggested form so that individual users can adapt it or adjust it to their own particular activities. A partial list of the publications already completed are as follows:

(1). Comments on Moldmakers' Contract.
(2). Suggested Job Descriptions and Classifications for a Mold Making Shop.
(3). Suggested Job Cost Estimate Form.
(4). Mold Progress Report Form.
(5). Suggested Shop Rules for Moldmaking Plants.
(6). Compression Type Mold Data Sheet.
(7). Injection Mold Data Sheet.
(8). Reinforced Plastics Mold Data Sheet.
(9). Suggested Moldmaker Apprentice Training Program.

Some of the special projects presently in committee action are:

(1). Formula for computing overtime charges.
(2). The production of a 20-minute color and sound film on the art of moldmaking.
(3). Statistical surveys of facts pertinent to moldmaking plants.
(4.) The work of standing committees on membership, public and industrial relations, accounting procedures, and policy.
(5). Standardization of mold finishes.

It is this type of action that is, perhaps somewhat slowly, but surely effecting a standardization of the thinking and resulting procedures in the field of moldmaking, to the benefit of the Moldmakers and the Plastics Industry they serve. The important thing to know is that people are diligently at work, exchanging ideas on a National basis, to increase efficiency, lower costs, and improve technically, through united effort, to attain a common goal of achievement. —THE END

Edited by:
HARRY T. DOUGLAS,
Executive Vice President,
Lunn Laminates, Inc.
Huntington Station, N. Y.

Reinforced Plastics

The Challenge of Reinforced Plastics

I imagine it ill behooves a member of the unstable plastics industry to pat the members thereof on their collective backs, but that is what I would like to do, at least by inference.

The event that triggered this desire was the recent accomplishment by the Nautilus and Skate with which we are all familiar, and of which we are all particularly proud. Having participated by manufacturing the sonar noses for these ships out of reinforced plastics materials, we, at Lunn, feel as though we helped, at least a little, to make these achievements possible.

Waxing a bit philosophically after the event, it occurred to me that most of the worthwhile things that have been done in this old world have been accomplished by the adventurous; the men and women willing to take a risk and a gamble; the people who are perpetually on the "frontier." I feel that it is readily apparent that there is no lack of this spirit among the people involved in reinforced plastics.

By contrast, one of my pet peeves is the almost complete lack of adventurous spirit in so many young fellows just completing their education and entering business or industry. Surprisingly, in my experience, this applies particularly to many young engineers. It seems the primary interest these days is security, spelled with a capital "S."

So many of them seem eager to scramble into the anonymity of a large company where they are content to handle much smaller phases of each problem hoping perhaps to some day advance to the top by attrition.

Many of these men did not seem to realize that if they had the confidence to choose a small business, however shaky, and work to build it, they could telescope many years' experience into a few months. It is in small business that the "big picture" must be looked at, and it is here that ability is readily perceived. Unfortunately, of course, so is mediocrity and perhaps that is their fear.

I have a mental picture of the engineers to whom this article applies arising as one and smiting me with their collective slide rules, but I also think that many small business men trying to avail themselves of engineering talents and seeking men who are scientific, analytical, and who possess the all-important "inquiring mind" will be inclined to agree with me.

The most valid argument I can think of is that where the risks are the greatest so, also, are the rewards.

—THE END

Influence of Resin and Process Variables on Polyester-Glass Laminate Properties
(*Cont'd. from page 811*)

Acknowledgment

The assistance of C. R. Smith in performing the experimental work, and of the Rohm & Haas Company's Physics Laboratory in carrying out physical tests, is gratefully acknowledged.

Bibliography

(1). Perry, H. A., Silver, I., Peugh, D., Barnet, F. R., Paper presented at the 9th Annual Conference, Reinforced Plastics Division, Society of Plastics Industry, Chicago, Ill., Feb. 3-5, 1954.
(2). Platts, R. E., M.S. thesis, Massachusetts Institute of Technology, Cambridge, Mass. (1957).
(3). Outwater, J. O., "The Mechanics of Plastics Reinforcement in Tension," **Modern Plastics**, 33, 7, 156 (March 1956).
(4). Hooper, R. C., "Molding-Finish Intersections in Fatigue of Glass-Reinforced Polyester Resins," **Plastics Technology**, 3, 8, 644 (Aug. 1957).
(5). Sampson, R. N., "Evaluation of Casting Resins Employing Strain Gage Techniques," **Modern Plastics**, 35, 6, 150 (Feb. 1958).

—THE END

ENGINEERING FORUM

Edited by:
PAUL E. FINA, *Dir. of Sales Engrng.*
The Fiberite Corp.,
Winona, Minn.

Compression & Transfer Molding

A Letter of Introduction

Dear Mr. Thermoset Molder:

May I look forward to servicing our plastics industry in the interest of expanding knowledge and use of thermosetting molding compounds by compression and transfer molding techniques?

Being employed by a molding compound manufacturer, I have occasion to visit with both molders and end-users. During the course of these visits, many excellent applications in plastics are reviewed and material choices, designs, and molding techniques are discussed. It is my feeling that the sort of engineering information uncovered in such open discussions is of value and can be disseminated. It is my intention in this column to parcel out useful ideas as the opportunities arise.

Since I am aware that many molders are spending their hard-earned dollars in their own private investigations, it is possible that it may be construed that I intend to violate their trust. Please be assured that no information jeopardizing a molder's program will be utilized. Only engineering pointers that can be applied generally will be developed in forthcoming issues of this Forum.

In general, the scope of my short articles will evolve around new potential applications, design tips, molding information, engineering data, field results, generally accepted standards, estimating, guides to sales engineers, and successful material choices.

For the edification of the engineer looking at plastics for the first time, the thermoset compounds commonly used in the compression and transfer molding field are phenolics, ureas, melamines, epoxies, and the polyester family. The fillers commonly employed are numerous; some of the fillers are to reinforce, some to enhance properties, some to lower costs, and some to give a combination of properties. It will not be within the scope of these articles to make direct comparisons. Specific papers on material evaluations are in another bailiwick.

Comments and suggestions always will be gratefully accepted.

Sincerely,
Paul E. Fina

—THE END

Fina on PT Editorial Advisory Board

In view of added duties involved with Auburn Plastics' integration with Norton Laboratories, John Woodruff has been forced to resign from our Editorial Advisory Board, effective August 31, after serving since the magazine's inception in February 1955. He is replaced as a Processing man on the Board by Paul E. Fina, director of sales engineering, The Fiberite Corp., Chicago, Ill.

Paul was born in Cleveland, O., and was educated at High School East Technical (Cleveland), and the University of Illinois, receiving a B.S. in 1941. This was followed by graduate courses in Business Administration. In industry, he did industrial engineering for Teletype Corp. from 1943-45; plastics estimating and planning for Cruver Mfg. from 1945-46; industrial engineer estimating and doing tool design for General American Transportation Corp. from 1946-48; and sales engineering for Drackett Corp., Plastics Div., from 1948-49. This firm was suceeded by Fiberite Corp., where he assumed his present position as director of sales engineering in 1949. He is an active member of SPE. Mr. & Mrs. Fina have two children, and live in Riverside, Ill.

—THE END

News of the Societies

Upper Midwest RETEC

SPE's Upper Midwest Section has scheduled a regional technical conference October 21, 1958 at the Curtis Hotel, Minneapolis, Minn. Topic will be "Epoxy Resins," and the symposium will include four combined sessions in the morning plus three, dual, concurrent sessions in the afternoon. Papers to be presented include:

Morning

9:30-10:05 "Relation of Chemical Structure to Properties of Some New Epoxy Resins" D. D. Applegath, Dow Chemical Co.

10:05-10:40 "Dynamic Mechanical Properties of Epoxy Resins" D. H. Kaelble, Minnesota Mining and Mfg. Co.

10:40-11:15 "Techniques of Evaluating Epoxy Foams" C. L. Segal, Hughes Aircraft Co.

11:15-11:50 "The Effect of Chlorine Content on Electrical and Physical Properties of Cured Epoxy Resins" W. J. Belanger and S. A. Shulte, Jones Dabney Co.

Afternoon

Section A

2:00-2:45 "The Olefin and Terpene Oxides—Novel Reactive Diluents for Epoxy Resin Formulations" Ralph J. Gall, John J. Rizzo, and Harry M. Castrantas, Becco Chemical Div., Food Machinery and Chemical Corp.

2:45-3:30 "Low Melting HET-Hexahydrophthalic Anhydride Mixtures as Hardeners for Epoxy Resins" C. S. Ilardo and B. O. Schoepfle, Hooker Electrochemical Co.

3:30-4:15 "Optimum Conditions for Curing Methyl Nadic Anhydride-Epoxy Casting Resins" Hans K. Weiss, National Aniline Div., Allied Chemical Corp.

Section B

2:00-2:45 "Properties of Epoxy Adhesives at Elevated Temperatures" E. W. McGuiness, Laboratory for Electronics, Inc.

2:45-3:00 "Dielectric Constants and Dissipation Factors of Epoxy Resins During Polymerization" John Delmonte, Furane Plastics, Inc.

3:30-4:15 "The Formulation of Versamide-Epoxy Plastic Solders for Automobiles" D. E. Peerman and D. E. Floyd, General Mills, Inc.

Registration fee, which covers luncheon and one preprint copy of RETEC papers, is $6.50 for SPE and SPI members; $7.50 for non-members. Arrangements for registration can be made by contacting J. C. Stuebner, Rohm & Haas Co., 533 Metropolitan Bldg., Minneapolis, Minn.

SPE New York Vinyl Group

An outstanding turnout of over 100 members and guests was again recorded at the second meeting of SPE's New York Section Vinyl Sub-Group, held at the Governor Clinton Hotel in New York City, June 18. Moderator for the meeting was Robert Braddecks, Jr., of Kentile, Inc., who had a few words to say about the general position of vinyl compounds in industry.

"Vinyl Chloride Copolymers—Bulk and Solution Polymerized" was the topic covered by Charles Droman, Bakelite Co. PVC-PVA copolymers were developed to overcome two inherent limitations in straight PVC: lack of flexibility and poor solubility. Flexibility was increased with external plasticizers; however, polyvinyl acetate in varying amounts is required to adjust the degree of solubility. Copolymers can be dissolved in ketones, ethers, and chlorinated hydrocarbons.

The first copolymers were prepared by solution polymerization, which involves preparation of mixed monomer solutions and catalyst, and reaction in an autoclave. The wet slurry is washed to remove catalyst and dried in a hot air blast. Bulk polymerization is simpler and cheaper, but does not produce as pure a product. A big problem here is the removal of the heat of reaction. Other topics covered by Mr. Droman were the use of copolymers in coatings and the molding of copolymers for phonograph records.

"Emulsion Vinyl Resins—Their Manufacture, Formulation, and Use" was the subject discussed by Goodyear Tire & Rubber Co.'s James F. Carraher. Dispersions for plastisol and organosol use are usually emulsion vinyls. Emulsion resins have many drawbacks for general purpose use among which are higher cost, poor electrical properties, less bulk density, and the need for milling. They are, however, especially good in vinyl latices and flooring.

M. W. Williams, Monsanto Chemical Co., addressed the group on "Vinyl Chloride Suspension Polymers," pointing out that this method is similar to bulk polymerization, but the monomer droplets obviate the heat problems. Pressure has to be used in an aqueous system, and the monomer boils at —14° F. Monomers are washed to remove the inhibitor, and polymerization takes place in the presence of a peroxide catalyst. High molecular weight resins are produced in the form of fine granular particles. Suspension polymers are the basic general-purpose PVC resins, and are widely used in calendering and wire extrusion.

A. W. Levenhagen

George R. Huisman

SPI Division Elects Officers

Society of the Plastics Industry's reinforced plastics division and the fiberglass-reinforced panel council have elected officers for the 1958-59 period. Incumbents for the current year include: A. W. Levenhagen, Molded Fiber Glass Tray Co., divisional general chairman; L. Stievater, Jr., McKesson & Robbins, Inc., divisional eastern chairman; Samuel A. Moore, Interchemical Corp., divisional midwestern chairman; George R. Huisman, Filon Plastics Corp., divisional western chairman and council chairman; and Leonard S. Meyer, council vice chairman.

SPI Labeling Contest

The Fourth Annual Informative Labeling Contest, sponsored by the Society of the Plastics Industry, Inc., has been scheduled to coincide with the Eighth National Plastics Exposition and the SPI Annual National Conference to be held November 17-21 at the Hotel Morrison, Chicago, Ill. As in the past, the contest is open to all companies and individuals manufacturing plastics end-products.

Individual awards will be given in each of the following product categories: apparel, building materials, floor and wall coverings, hardware, home furnishings, housewares, notions, toys, and miscellaneous. A grand award for the "best-in-the-show" labeling also will be selected.

Entry of the actual product is urged, when feasible, together with identifying labels to assist the judges in making their determination. Awards will be determined on the basis of which best tells consumers, what the product is by brand name or other identification, what it is made of, how it is used, how to take care of it properly, and what guarantees, if any, are offered by the makers. Products and labels must be postmarked not later than October 26, 1958. Entry blanks are available by writing to the Society of the Plastics Industry, Inc., 250 Park Ave., New York 17, N. Y.

News of the Industry

Utrilon all-vinyl sport shoes and sandals.

All-Vinyl Molded Footwear

On the golf course, at the beach, and "pour le sport" in general, you will be seeing signs of what may well be the trend in casual footwear—all-vinyl loafers and sandals. Injection molded under 80,000 psi., each shoe leaves the machine as an entity. An extruder, acting as a plasticizing unit, feeds the molten plastic to the injection machine under 40 tons of pressure. Cycle time is approximately 15 seconds, and the three man-operated machine contains molds and lasts for ten shoes.

The basic molding unit was developed in France about four years ago, and 19-million pairs of the low-cost footwear were sold in France last year. Production was started in England and Australia two years ago by Leonard Rae and Stanley F. Reed, who formed Universal Injection Moulding Pty., Ltd., of Australia. The tradename Utrilon designates both the material and the process. Utrilon Corp. has been set up and, from world headquarters in New York City, will administer the following subsidiaries: Utrilon Industries (France), S. A.; Utrilon Industries (Nigeria), Ltd.; and Utrilon Industries (S. A.) Pty., Ltd., South Africa.

The company expects to produce 2-million pairs of shoes annually in the United States, beginning in December of this year. Until that time, imported shoes are being sold on an experimental basis. Present plans call for factory space of about 25,000 square feet, and the employment of about 100 persons. Probable location, Puerto Rico.

Utrilon intends to concentrate primarily on casual and beach footwear, children's play shoes, and storm footwear. A variety of colors will be available, including browns, clear opaques, and metallic tints. Extremely durable, the men's loafers feature traction treads for sure footing on boat decks and wet grass. Of course they require no polishing, a damp cloth restoring their original gloss.

Smooth Sailing for Anchor

Anchor Plastics Co., Inc., well known New York extruder, marked a nautical milestone recently with the quarter-billionth foot of Aeroflex P tubing. Designed for use in aerosols, atomizers, squeeze bottles, and lotion pumps, the tubing has now been produced in sufficient quantity to circle the earth at the equator twice. The dip tubes were first produced in 1951.

Nopco Moves Its Headquarters

General offices of Nopco Chemical Co. and its subsidiary, Metasap Chemical Co., have been moved from Harrison to 60 Park Place, Newark, N. J. The new headquarters will accommodate executive, accounting, advertising, and sales departments; and will leave additional facilities in Harrison for expansion of the Nopco laboratories. Engineering, legal, production, purchasing, receiving, and shipping departments will not be moved.

Plastics Distributors Expands

A new warehouse and office building are being erected by Sommers Plastic Products Co., a distributor for General Tire & Rubber Co.'s plastics division. The headquarters will occupy a site adjacent General's distribution center and recapping plant in East Rutherford, N. J. The move reportedly was dictated by the need to consolidate stock operations and accelerate shipments to manufacturers served by Sommers. In the past, warehousing and sales operations had been scattered in seven different locations throughout New York City.

Building plans allow for future additions, in all probability the transfer of Laminations, Inc., a press polishing and laminating facility now located in Astoria, L. I., N. Y. Sommers distributes both supported and unsupported vinyl sheeting for General, as well as for Alkor, G.m.b.H., and Milan Art Plastics, Inc.

Hi-Vacuum Firms Join Forces

Two of the world's leading producers of high vacuum equipment have signed a five-year cross-licensing agreement—National Research Corp., Cambridge, Mass., and Leybold-Hochvakuum-Anlagen, G.m.b.H., Cologne, Germany. Agreement was made on behalf of NRC Equipment Corp., a wholly-owned National Research subsidiary. The agreement covers four specific areas of applied high-vacuum engineering of major significance to the electric power and electronics industries, and to producers of thermosetting resins. New methods include high vacuum drying, degassing, impregnating, and filling of transformers and other electrical equipment.

German data show that superior electrical and physical characteristics result from vacuum processing. Insulation resistance of some commonly-used materials can be increased up to 100 times, and loss factors reduced by 80-90%. German engineers and technicians will be sent to this country to render assistance to NRC customers on request, and detailed drawings and specifications will be transferred to this country on a royalty basis.

Reorganizes Canadian Set-Up

Allied Chemical Canada, Ltd., a newly-established Dominion corporation, will be the successor to the following five Canadian companies: The Barrett Co., Ltd.; Brunner Mond, Canada, Ltd.; National Aniline & Chemical Co., Ltd.; Nichols Chemical Co., Ltd.; and Semet-Solvay Co., Ltd. Officers of the new corporation and their former positions are as follows: president, R. W. Atkinson, vice president of Brunner Mond; executive vice president, E. P. Aikman, Nichols Chemical vice president; and vice president, Gordon B. Schroeder, vice president of Barrett.

Wasco Chemical Buys Celastic

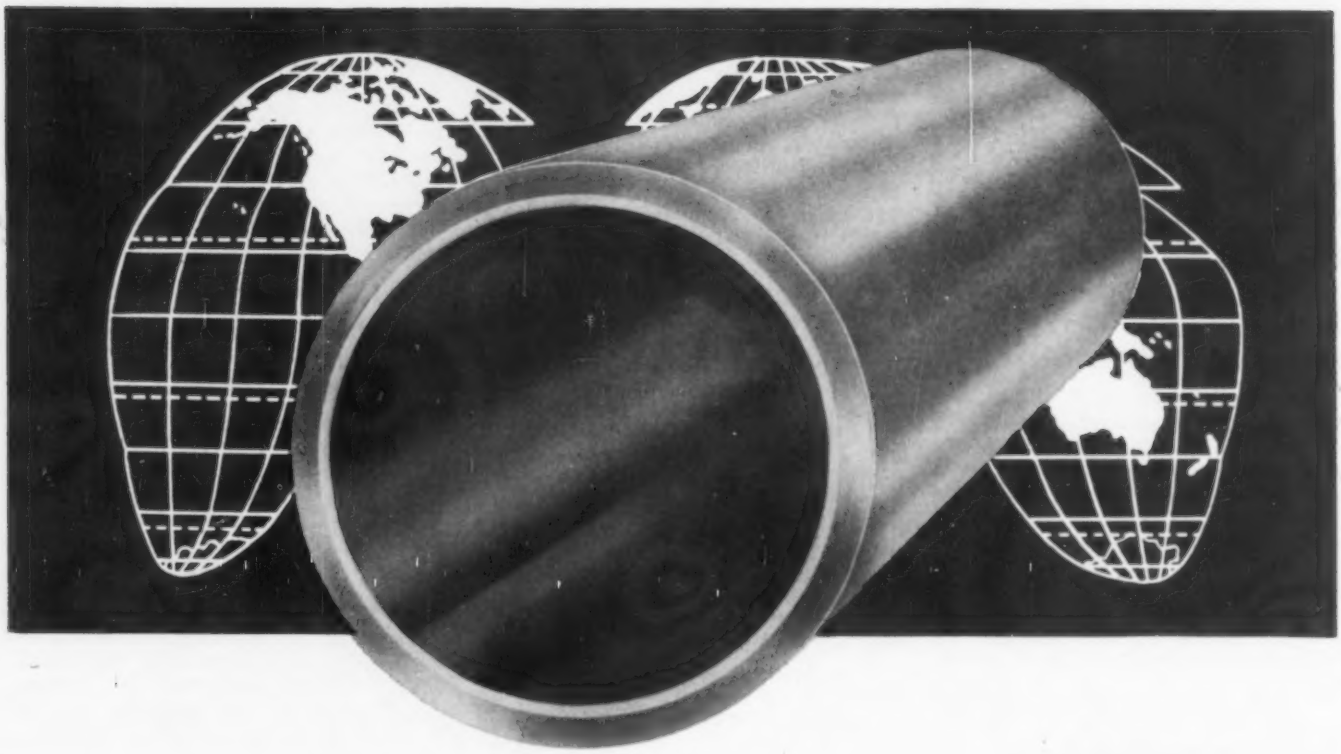
Celastic Corp. of Kearny, N. J., a company owned jointly by E. I. du Pont de Nemours & Co., Inc., and United Shoe Machinery Corp., has been purchased by Wasco Chemical Co. Another step in that firm's expansion program, the acquisition is expected to diversify Wasco's products (acrylic sheet and other plastics materials) available to the construction industry. Celastic has been manufacturing a colloid-treated fabric used widely in the shoe industry, building construction, and for boats. Russell Hamilton will become general manager of Celastic, which will operate as a Wasco division.

Third Resistoflex Expansion

A 30,000 square-foot extension will be added to Resistoflex Corp.'s main plant at Roseland, N. J. The plant itself was built in 1955, and subsequently was enlarged in 1956. Increased demands for the firm's Fluoroflex-T pipe, fittings, and joints dictated the move. The added space will be given over entirely to production and fabricating equipment.

Exclusively Devoted to the Manufacture and Development of Bimetallic Cylinders and Integral Extruder Barrels

Xaloy SERVES THE NEEDS OF THE PLASTICS INDUSTRY... world-wide



Only Xaloy and Xaloy 306 can be centrifugally cast to close tolerances for every size extruder

Whether you need a close tolerance with exacting micro inch finish or a special new design, you'll find Industrial Research Laboratories ready to serve you. Xaloy is wholly devoted to the manufacture of the finest quality cylinders and liners for original and replacement equipment on all leading extruders. Industrial Research Laboratories is the only company engaged in advanced development work to meet the growing needs and individual problems of plastics processors.

Write or phone to Industrial Research Laboratories for the fast, personal service of the men who produce Xaloy Bimetallic Cylinders.

Send for this new Xaloy Engineering Catalog.

SOCIETY OF THE PLASTICS INDUSTRY · SPI

INDUSTRIAL RESEARCH LABORATORIES

Division of Honolulu Oil Corporation
961 East Slauson Avenue • Los Angeles 11, California
Telephone: ADams 1-4374

Dewey & Almy Chemicals Plant

W. R. Grace & Co.'s Dewey & Almy division has announced plans to build a $4-million organic chemicals and battery separator plant at Owensboro, Ky. Scheduled for completion next year, the new unit should more than double the division's capacity for producing vinyl acetate polymers and copolymers for paints, adhesives, paper coatings and textile sizing, as well as its styrene-butadiene copolymer latices. Increased capacity is expected also for the resin-impregnated fiber insulators which are inserted between the lead plates of automotive storage batteries.

Stewart Bolling Rotor Patent

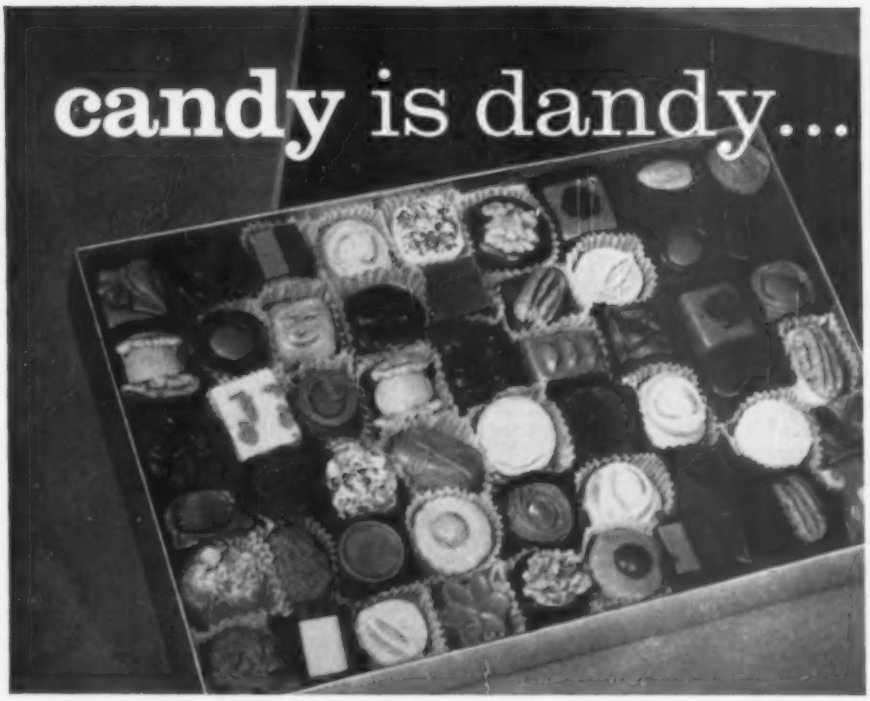
Earlier this year Stewart Bolling & Co., Cleveland, O., was granted a patent (No. 2,820,618) for an arrangement of driving rotors of intensive mixers independently, thereby eliminating connecting or differential gears. This makes front and back rotors interchangeable. The time cycle of plasticization, as well as the even, rapid dispersion of fillers and pigments can be decreased materially by increasing rotor speed and chamber pressure. Power increase is proportional and, due to the limited centers of rotors, connecting gears already have passed their practical limits. The new patent should, therefore, be of considerable interest to the plastics and rubber industries.

Reichhold Opens Epoxy Plant

Commercial production of epoxy resins at Ballardvale, Mass., was begun a couple of months ago by Reichhold Chemicals, Inc. Expected annual capacity is 10-million pounds of both liquid and solid types, which will be marketed under the trade-name Epotuf. Use of epoxies grows by approximately 50% each year, particularly in surface coatings and tooling for which RCI supplies Polytool compounds.

Carlon Enters New England

Plastic Industrial Products Co., Somerville, Mass., has been acquired by Carlon Products Corp. of Cleveland, O. It will operate under the latter firm's custom extrusion division, and will be the first manufacturer of flexible plastic pipe in New England. Former president John Beaumont will remain as general manager of the plant. In addition to the Carlon line of polyethylene, Kralastic, and PVC piping, the new subsidiary will extrude tubing, welting, spline, and window channeling.



but for display purposes,

Replicas made with

A-C® Polyethylene are better!

It looks exactly like the real thing—but it isn't! Even placed side-by-side with a box of real candy, the exact copies are indistinguishable from actual candy. Made by Knechtel Laboratories of Chicago, they are used for display purposes by many of the nation's leading candy manufacturers. Other perfectly detailed replica work is done by Knechtel on meats, fruits and vegetables. And A-C Polyethylene is *the* basic ingredient in *all* of these items.

This is just one example of the many opportunities this new technique of slush molding with low-viscosity A-C Polyethylene offers. Profitable short runs are now possible because of low mold cost and low initial investment in equipment. Your engineers can design more detailed objects, which can then be executed by cheaper mold processes. A wide variety of part sizes and shapes is possible, too, ranging from small pieces like the candy above to 50-ounce parts. You can transfer to slush molding many of the parts now injection molded, doing it better, faster and more economically with A-C Polyethylene blends. These blends create an *entirely new material*, one that can be tailor-made to fit your needs. Wall thickness and finish can be controlled while maintaining faithful mold reproduction.

Polyethylene slush molding lends itself to hand pouring operations or semi-automatic and automatic machines at low pressures because of the low-viscosity characteristic of the A-C Polyethylene used. Whichever method you adopt, equipment and costs are surprisingly low.

You owe it to yourself to carefully consider this new, profitable process. Write *today* for full information, specifying your intended use of A-C Polyethylene. It helps us to help you.

SEMET-SOLVAY PETROCHEMICAL DIVISION

Dept. 527-R, 40 Rector Street, New York 6, N. Y.

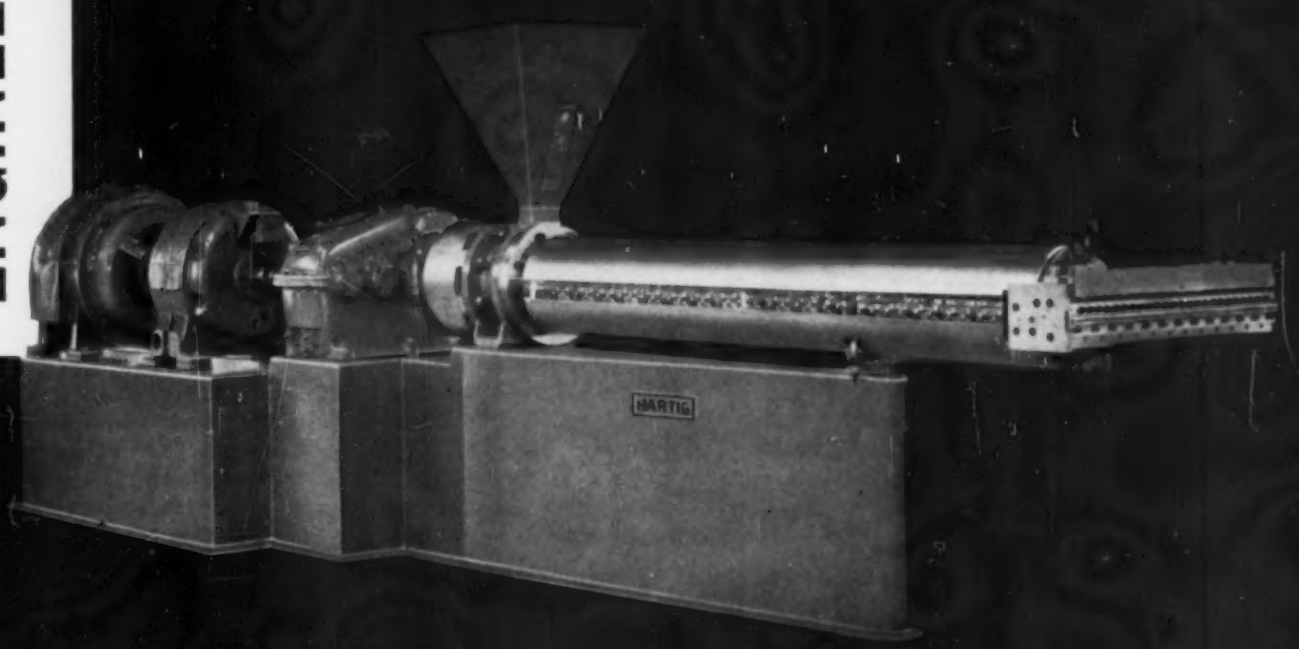
National Distribution • Warehouses in Principal Cities

Allied Chemical

ENGINEERED INSTALLATIONS

HARTIG extruders and matched auxiliary equipment

Hartig 4½" Extra Long Extruder, 24:1 L/D with sheeting die



for

- Sheet Extrusion — Vacuum Forming
- Film Extrusion — Blown Tubing, Unsupported Film, Laminating
- Wire and Cable — Insulation and Sheaths
- Pipe, Tubing, Rod and Profile Extrusion
- Blown Containers — Molding
- Compounding — Reprocessing

The 130 years of experience of the John Waldron Corporation is also available for complete process engineered installations.

materials now being processed on Hartig Extruders

Nylon	Acrylic Resins	Polyvinyl Chloride
Polystyrene	Vinylidene Chloride	Casein
	Polypropylene	Polyvinyl Butyrate
Cellulose Acetate	Rubber	Ethyl Cellulose
Cellulose Acetate-Butyrate	Fluorothene	Polyethylene

extruder specifications

sizes	1¼" to 12"
capacities	15 lbs/hr to 3000 lbs/hr depending on the nature of the job.
L/D ratios	15:1, 21:1, 24:1, and 30:1.
drive	Variable speed motor. Herringbone gear reducers.
thrust bearing	Spherical roller bearing for radial loads, and self aligning spherical roller bearing for thrust loads—completely enclosed in a bronze housing and force lubricated.
feed	Fabricated throat section with provision for water cooling.
cylinder	Steel barrel with centrifugally cast Xaloy liner.
screw	Alloy or stainless steel with stellite tipped flights. Constant pitch, decreasing depth, or variable pitch. Self venting, recirculating.
closure	Clamp type.
temperature controls	Heated by means of band heaters or cast-in-aluminum calrod units. Controls are proportioning type or stepless (saturable core reactors).
	Cooled by controlled air or water along entire length of barrel.
venting and devolatilizing	Special screw construction for elimination of porosity, optional.

auxiliary equipment

dies	Film or laminating dies for widths up to 120".
	Blown tubing dies up to 48" diameter, and for lay-flat tubing up to 144".
	Pipe dies, profile dies.
	Sizing and cooling dies.
	Adjustable centering crossheads.
	Special purpose dies.
payoffs, takeoffs troughs	Film takeup units for widths to 120".
	Blown tubing takeup units with collapsing roll assembly. Constant tension. Also available for lay flat tubing up to 144".
	Pipe pulloff units.
	Water troughs.
	Capstans.
	Dual reel high speed continuous takeup with adjustable traverse. Constant tension, counter.
	High speed payoff stand with automatic brakes and dancer for tension control.
	Conveyors with counterbalanced pressure roll.
processing equipment	Cooling and polishing rolls.
	Laminators for web widths to 96" with unwind and rewind stations.
	Pelletizers.
special purpose auxiliary equipment	Hartig engineers have designed, built, and installed extruders and auxiliary equipment for specific production tasks. In doing so, they may already have solved your problem.

Send for your copy of the new booklet describing the complete line of Hartig Extruders and Auxiliary Equipment.

MIDLAND-ROSS CORP.

HARTIG EXTRUDERS

Established 1890
Division of Midland-Ross Corporation
Mountainside, New Jersey

Dow Corning Syl-Mer Promotion

A nation-wide promotion of Syl-mer silicone finish for textiles has been announced for this Fall by Dow Corning Corp. The third major drive launched by the firm in support of the water-repellent, spot-resistant finish, it will emphasize fashion. Highlighting the program will be a series of live model fashion shows staged by Harper's Bazaar magazine's fashion staff in leading department and specialty stores throughout the country.

Offers Ideas About Presses

Given—a trend toward small molds and increased competition; what should a molder do about presses? According to I. A. Tochner, vice president of Wagner Brothers' subsidiary, Automatic Molding Machine Co., —he should consider the small presses, especially if automatic operation is contemplated. Maintenance should be kept to the barest essentials, and the press should operate on the air-draulic principle. Where speed is essential, an air-operated toggle press should be both rapid and safe. For versatility, a small plant might purchase a vertical press for compression molding; convert it to transfer molding; and, by the addition of another hydraulic cylinder on the mold parting line at the rear, convert it to straight injection molding.

Call For Philip Morris

Philip Morris, Inc., the well-known cigarette company, has entered the plastics field through the purchase of Polymer Industries, Inc., Springdale, Conn. A producer of industrial adhesives, textile chemicals, and intermediates, Polymer has been in existence since 1946. The move ties in with Philip Morris' diversification program, and should give Polymer to expand and streamline its organization.

PMC Opens Dinnerware Plant

Plastics Mfg. Co. has moved into its new plant and offices in the Santa Fe industrial district of Dallas, Tex. The only such plant built specifically for the manufacture of melamine dinnerware, it features the most modern facilities and equipment. The company maintains its own design, engineering, research, and development departments, as well as a tool and die department. Before marketing, all dishes are boiled in sulfuric acid, baked, and otherwise tested to assure the highest quality standards.

The first firm to produce the dinnerware on a commercial basis, PMC is a leader in an industry which sold an estimated $60-million worth of the melamine dishes

PMC melamine dinnerware molding plant.

last year. Among other firsts claimed by the company are colored dishes, mass-produced decorated patterns, and color-on-color. Each specially-designed press is capable of exerting 3,000 psi. of pressure at temperatures up to 300° F., and is equipped with individual air conditioning.

Plastics Historical Exhibit

Considerable interest has been evinced in the Plastics Historical Exhibit which will be located in the Theme Center at the Eighth National Plastics Exposition. As you all undoubtedly know, the Exposition will be held at the Chicago International Amphitheatre, November 17-21. Based on the amount of interest, it will be determined whether or not to set up a permanent Plastics Museum.

The exhibit will be divided into the following seven categories: commerce and industry, communications, fashion, fun, living, military, and transportation. Entry forms can be obtained from the Society of the Plastics Industry, Inc., 250 Park Ave., New York 17, N. Y. All inquiries should be directed to Miss Harriet Raymond, chairman of the exhibit subcommittee.

More About Polyurethane Foam

Polyurethane foam of the polyether type is being promoted by Bostrom Mfg. Co., Milwaukee, Wis., for use in knee action and standard seating for trucks, tractors, and construction machinery where there is exposure to the elements, gasoline, oil, and chemical spillage. Company sources report that, after extensive laboratory and field testing, the molded foam product is superior in many respects to other commonly used cushioning materials. Highly resistant to abrasion and tearing, it is affected negligibly by exposure to sunlight and air.

Opens New Distributor Office

The Pacific Coast and Canadian sales representatives for Eastman Chemical Products, Inc., Wilson & Geo. Meyer & Co. and its affiliate, the Wilson Meyer Co., have opened their new Southern California offices, warehouse, and bulk storage facility. Located at 2060 South Garfield Ave., Los Angeles, the ½-million dollar plant doubles the firms' former facilities.

Among the items distributed by the companies are the entire Tenite line of plastic materials, plasticizers, solvents, antiozonants, antioxidants, and basic raw chemicals. Four 15,000-gallon underground tanks and one 6,000-gallon surface tank are available for blending plasticizers to customers' specifications. A spur track provides rail service to and from the plant. Headquarters for the Meyer firm are in San Francisco, and district offices are located in Portland, Seattle, and Salt Lake City.

Pebbles, Plastics, & Planes

Strange as it may sound, more than 20 tons of pebbles were used to produce the Air Force's supersonic fighter-bomber, the F-105 Thunderchief. These pebbles were used by Republic Aviation Corp. to fortify its Trulite epoxy molds, and were found to impart a strength greater than concrete. These molds then were used to shape the plane's vital parts.

Republic's non-metallics research section points out that pebble-filled plastic molds can be made in as little as 1/10 the time and 1/5 the cost of previously-used steel, aluminum, and kirksite tools. Some of the pebble-epoxy tools used on this particular job measured up to six by 14 feet and weighed 1½ tons. These particular pieces are used to stretch thick pieces of aluminum over the fuselage.

Kralastic Licensed Abroad

United States Rubber Co. has licensed Societe d'Electro-Chimie d'Electro-Metallurgie et des Acieries Electriques (UGINE) to produce Kralastic impact-styrene and Paracril oil-resistant synthetic rubber. The American firm will also provide technical assistance to the Paris, France chemical manufacturer with respect to plant construction and operation. UGINE expanded into organic chemicals production following World War II, and should now be one of France's principal suppliers of specialty synthetic resins and rubbers.

Expands Plastisol-Latex Line

A New York City firm, Morningstar-Paisley, Inc., is expanding its latex and plastisol sales and technical departments. Laboratory facilities have been increased, and additional pilot plant equipment has been installed. Large-scale processing equipment will be set up at the Clifton, N. J., plant, with completion of the project anticipated by late summer next year.

M-P entered the field late last year with the purchase of Federal Latex Corp. and Federal Chemical Corp. Well known as a manufacturer of PVA and copolymer emulsions, the company plans to expand its line to include liquid vinyl chloride, natural

latex, and synthetic latex. Plastisols, including organosols, will be tradenamed Morpasol, and will consist of flow-controlled formulations for dipping, rotational and slush molding, spray coating, and both roller and knife coating.

Urethane Foam Scores Twice

Urethane foam cushions, Herithane and Equation 1, are being used by Heritage Furniture Co., High Point, N. C. The former replaces foam rubber, and the latter is used by the firm in place of spring down. Company representatives feel that these two cushioning materials offer every style, shape, depth, and resiliency desired.

Earlier, Heritage put urethane foam through severe comparison tests with foam rubber at U. S. Testing Laboratories, and found that it offered several advantages. Among them are its lightness—about ⅓ the density of latex foam, a higher tensile strength which permits stitching and tufting to fabrics, and resistance to the usual dry cleaning solvents. Urethane constituent materials are supplied by Allied Chemical's National Aniline division.

Joint Plastic-Pipe Venture

A joint project is being sponsored by Tube Turns Plastics, Inc., and Swepco Tube Corp., whereby unplasticized PVC pipe will be manufactured by Swepco, fittings will be made by Tube Turns, and the latter firm will market both items under the brandname Swepcore UPVC l'ned pipe.

Presently available are the pipe, which is furnished with a steel shield, and the UPVC-lined cast iron fittings. Cast aluminum and cast steel UPVC-lined fittings and Swepcore pipe with aluminum, stainless steel, or special alloy shielding are available on special order. Present sizes range from ½ through three inches. The piping is said to combine the corrosion resistance and non-aging characteristics of UPVC pipe with the strength of metal and improved temperature resistance. It should handle temperatures up to 190° F., and pressures up to 500 psi.

Five-Mil Vinyl Fruit Tray

Another useful packaging innovation has come to us from abroad—a 5-mil vinyl tray for shipping such soft deciduous fruits as peaches, nectarines, plums, persimmons, and fresh figs. The original manufacturer, Compagnia Italiana Nest-Pack S.P.A. of Bologna, Italy, has licensed its production methods, process, and special vacuum-forming units to the Pantasote Co. of New York and New Jersey. The firm's Eleonora Chemical division makes the vinyl resin, another division calenders it into film, and the parent firm vacuum-forms the 5-mil sheets which measure 13 by 16 inches. Finished trays are sold under the trade-mark Panta-Pak.

Trays are available in a wide range of colors, or in clear film to fit standard United States shipping containers. Competitive in price with paper board, the trays are able to withstand refrigeration for several days. Over 4-million have already been used by West Coast fruit shippers.

FMC Reorganizes Departments

Two new chemical departments and the enlarged executive committee are now functioning at Food Machinery & Chemical Corp. The new units are the FMC Organic Chemicals department and the FMC Inorganic Chemicals department; general managers of which are, respectively, Alfred T. Loeffler and Frederick A. Gilbert.

The first-mentioned department includes the Niagara Chemical division and the Chemicals & Plastics division; Becco Chemical, Westvaco Chlor-Alkali, and Westvaco Mineral Products divisions make up the Inorganic Chemicals department. All present products and trade-marks will be retained, and new product development efforts will be intensified.

Packager Doubles Production

Using Bakelite polyethylene film and a new, high-speed automatic packaging machine, Princeton Farms, Inc., Princeton, Ind., has been able to boost its production of popping corn by 100%. One of the major producers in its field, Princeton had been packaging its one- and two-pound bags of popping corn by hand. The prefabricated bags were fed manually into a rotary-type packaging machine. Three employees were required.

Polyethylene film's moisture retention qualities, superior puncture strength, and visual appeal made it ideally suited to the application.

Enjay Enters Plastics Field

Climaxing a four-year sales agreement with Spencer Chemical Co., one of the leading marketers of petrochemicals, Enjay Co., Inc., has announced its entry into the plastics field. The firm will offer polypropylene through its own sales organization and, under an agreement, supply Spenser with polypropylene for resale throughout the United States.

Enjay polypropylene will be supplied from a plant which will be constructed and operated by Humble Oil & Refining Co. Initial output is set for 40-million pounds annually.

A high molecular weight adipate plasticizer!

RC

POLYMERIC BGA

Recommended for use in PVC compounds requiring a primary polymeric plasticizer with outstanding performance qualities such as:

★ Resistance to extraction
★ High rate of solvation
★ Low order of volatility
★ Migration resistant
★ Heat and light stability

Check RC POLYMERIC BGA in wire insulation compounds, gaskets, vinyl-metal laminates, and non-migrating film and sheeting!

WRITE FOR SAMPLES! We'll send you a brochure on all RC products that can speed your operations, improve your products.

RUBBER CORPORATION OF AMERICA

READY . . . RELIABLE . . . RC. SERVING AMERICAN INDUSTRY, SINCE 1930.

New South Road, Hicksville ~ N. Y.

Sales Offices: NEW YORK • AKRON • CHICAGO • BOSTON

Names in the News

Walter J. Beadle, a vice president and member of the executive committee of E. I. du Pont de Nemours & Co., Inc., has retired after 30 years service. He will remain a director of the company. **George E. Holbrook,** general manager of the elastomer chemicals department, has been elected a vice president, director, and a member of the executive committee. **Charles B. McCoy** former assistant general manager of the electrochemicals department, replaces Mr. Holbrook.

Everett Sklarz has been appointed eastern regional resin sales supervisor for Archer-Daniels-Midland Co., supervising the territories of New York, Cambridge, Philadelphia, and Baltimore. A 10-year ADM employee, Mr. Sklarz previously had served as a chemist with Sherwin-Williams Co. and Vita-Var Corp.

Howard A. Johnson has been added to the staff of American Molding Powder & Chemical Corp. as production and plant manager. In 20 years of service with Interchemical Corp., Mr. Johnson held the positions of industrial engineer, production manager, and process engineer. **Myles Schneider,** former assistant to AMP's technical director, has been named director of technical sales service. He previously had served with Naugatuck Chemical in the Kralastic section. In a third appointment, **Morty Winter** has been moved from assistant to the production manager to sales service representative.

James F. Murphy, Jr., has been named project manager for Dewey & Almy Chemical Co.'s new $4-million plant in Owensboro, Ky. He will be responsible for plant engineering, construction, staffing, and start-up. Mr. Murphy, assistant chief engineer, will return to that job when his Owensboro assignment is completed. Two new appointments for the new plant have been announced: **Craig Falk,** as chief of the organic chemicals section; and **Richard R. Shallberg,** as chief of the battery separator area.

Ralph I. Dunlap was recently appointed to the newly-created position of production technical service manager, eastern operations, for Monsanto Chemical Co.'s plastics division. He will be responsible for improving manufacturing processes in Springfield, and for liaison with the research and engineering departments. Simultaneously, **Cecil E. Johnson** was appointed assistant research director in charge of planning, personnel, and control functions.

Alfred S. Meyerson has been appointed a sales representative for Commercial Plastics & Supply Corp., New York, N. Y. For the past three years, he had been sales correspondent for the New York distributor.

Chester E. Shepperly

George R. Frick

George R. Frick and **Chester E. Shepperly** have been appointed district managers, respectively, of Boston and New York City for L. O. F. Glass Fibers Co. Six field representative assignments include **Donald R. MacNary,** New York; **Bill O. Nye,** Toledo; **John F. Newton,** Chicago; **John A. Dahlstedt,** Chicago; and **David D. Bixler, Jr.,** Dallas.

Richard A. Pim has been named chief engineer for the eastern division of L.O.F. Glass Fibers Co. He will supervise all engineering operations for the plants in Defiance, O.; Parkersburg, W. Va.; and Waterville, O.; and will make his headquarters at the firm's technical center in Waterville. Mr. Pim has served the glass industry for 22 years.

George Lubin has joined Grumman Aircraft Engineering Corp., as staff consultant. A veteran of over 22 years in the plastics field, Mr. Lubin has served as chief chemist for Columbia Records; chief materials engineer, rigid plastics, for New York Navy Yard; as director of research for Bassons Industries Corp.; and most recently as technical director for the Lawrence Wittman Co.

George Lubin

Oscar H. Johnson has been appointed director of research and development for the organic chemicals department for Food Machinery & Chemical Corp., and **Hans O. Kauffmann** will serve the inorganic chemicals department in the same capacity. The latter previously served as technical director for the Becco Chemical division, and Dr. Johnson was director of research for the Niagara Chemical division.

Victor E. Buehrle, Jr., has joined the sales staff of Columbian Carbon Co., and will be attached to the Akron office. He previously served with B. F. Goodrich Co., and General Tire & Rubber Co.

George Myers has joined the sales staff of Thiokol Chemical Corp., and will serve with the polyurethane sales group. He previously sold for Sherwin-Williams Co., and for Kelite Corp.

William C. Zekan, a 20-year associate of A. Schulman, Inc., has been named executive vice president of the firm. In another move, **Dudley G. Brattin** was given the post of treasurer and comptroller.

Ralph T. Urich has been named vice president-general sales manager of Reichhold Chemicals, Inc. A 19-year veteran, he was first concerned with color pigment research and sales. Mr. Urich was elected vice president a year ago.

Frank C. Arnold has been appointed northeastern representative for Appleton Machine Co., manufacturer of calenders, slitters, rewinders, and other equipment. He was formerly associated with Pusey & Jones Corp. as a sales engineer.

Joseph P. Fuller has been appointed assistant manager, eastern district, for Du Pont's elastomer chemicals department. Headquarters will be in Trenton, N. J.

News from Abroad

Plastics in India

With 80 factories and a number of cottage-scale producing units, the Indian plastics industry shows an investment of about $16-million, with over 15,000 workers engaged in production. Injection molding was introduced in 1948, and there are now two calendering plants with a capacity of over 800 long tons of PVC annually.

Phenolic molding powder is the only plastic material produced locally, and output rose from 382 long tons in 1953 to 728 tons in 1955. Other resins are imported; however, India envisages domestic production of the following: urea, polystyrene, polyethylene, PVC, and cellulose acetate. Plans call for the production of styrene at the initial rate of 3,000 tons yearly, and polyethylene at the 5,500-ton rate.

Imports during the 1955-1956 fiscal year totaled 7,270 tons valued at over 23-million rupees or about $4.5-million. Semi-fabricated imports ran to about $2-million. The United Kingdom supplied 57% of the total imports for that year; West Germany, 15.3%; United States, 12.2%; and other countries, 15.5%. The American total represented a 100% increase over the previous year.

The Government Export Promotion Counsel assists the local industry, which exports to Ceylon, Burma, Aden, Zanzibar, Kuwait, Saudi Arabia, Sudan, Tanganyika, Kenya, Afganistan, and Iraq. The government allows a rebate of import duty at specified rates on plastics materials used in the manufacture of plastic goods for export. This is expected to make Indian producers competitive with Hong Kong. Bombay and Calcutta are the principal centers of production and distribution, and it is there that efforts have been made to initiate local production of compression and injection presses. Some molds are made domestically, but 250 were imported in 1954 for a value of about $100,000.

Plastics in Austria

Plastics material production rose about 30% between 1954 and 1955, leveling off to a 10% increase for 1956—11,000 tons. Halvic Kunststoffwerke, G.m.b.H., the country's only producer of PVC, produced 2,100 tons that year for almost 20% of the total. The company hopes to triple its output by 1958.

Many manufacturers expanded their capacities, and some new facilities were built for polyethylene piping and tubes, floor coverings, housewares, and foamed products. About 75 firms are engaged in plastics processing, and some 150 handicraft enterprises are working in this field. Increased requirements have brought about increased demands for imports; from 7,350 tons in 1955 to 10,160 tons in 1956—a 38% increase. U. S. suppliers saw an increase from 525 to 1,333 tons.

Plastics in Italy

Italy ranked fifth among plastics materials producers in Europe during 1955, and accounted for a little over 3% of the world's production. Consumption had increased meanwhile to approximately 80,000 metric tons. There are some 20 resin producers, plus about 1,250 molders, extruders, calender operators, coaters, vacuum formers, and other processors.

Consumer education is fostered yearly by the international fairs held in Milan, Bari, Palermo, Verona, Cagliari, and Padova; and the National Show of Technical Progress in Torino. Institute Italiano dei Plastici was created recently to educate the public and promote progress in quality and methods of plastics production.

Plastics materials have about the same uses in Italy as in other countries, and a large variety of excellently-designed, quality items have been produced. Plastic products are not subject to special legislation; thus, private initiative is unhampered. Imports and exports are subject to customs duties ranging from 10-30% of GATT schedules. Licenses for import from the United States are allowed freely, since they result in a greater value for exports of finished products. U. S. imports in 1955 amounted to 2,705 tons valued at $2,200,000, whereas exports amounted to 13,380 tons valued at $6,700,000.

Following is a table giving estimated consumption (metric tons) of plasics materials for the period 1955 through 1958:

	1955	1956	1957	1958
Styrenes	6.000	7.000	9.000	12.000
Acrylics	1.850	2.500	3.000	4.000
Vinyls	18.100	24.000	31.000	40.000
Polyethylene	3.800	5.500	9.000	12.000
Polyamides	50	90	100	150
Cellulosics	5.600	6.500	9.000	12.000
Phenolics	13.900	19.500	25.000	35.000
Melamine & ureas	18.900	21.000	28.000	38.000
Polyesters	600	1.000	1.300	2.000
Others	11.000	14.000	18.000	24.000
Totals	79.800	101.090	133.400	179.150

Plastics in Lebanon

There are no present plans for producing molding materials in Lebanon, the local industry being limited at present to two processing plants in Beirut which are molding phenolics, ureas, and polystyrene. One plant operates three compression presses and one preforming machine, all of British make, to produce plates, tumblers, cups, ash trays, bottle caps, and similar items. The other firm uses approximately 10 metric tons of polystyrene to manufacture combs and buttons. This company employs German injection molding machines.

Expansion is dubious, since there are relatively few consumers and little possibility of export on a significant scale. There is no import duty or license required; however, there is a 25% duty collected on finished products plus a 3% municipal tax. Materials formerly were obtained from England and the United States, but both Germany and Italy have been able to undersell them.

Plastics in Nicaragua

Molding materials are not produced in Nicaragua, and output is limited to the manufacture of buttons, tableware, and combs by two small processing plants. Material imports have come entirely from the United States, and include over 100,000 pounds of urea-formaldehyde and 15,000 pounds of polystyrene annually.

Processors import material in 50-kilogram drums, with terms being sight draft against delivery of shipping documents. The Nicaraguan government requires that an importer deposit, in local currency, the dollar equivalent of the order before an import permit is issued. Future of the plastics industry in Nicaragua is said to be bright, but more impetus is needed to stimulate local buying.

Ranks 4th As Plastics Producer

With an output of over 340,000 tons in 1957, Japan now ranks as fourth largest producer of plastics, after the United States, West Germany, and Britain. Yoshihige Harada, president of the Japan Plastics Industry Association, pointed out in a guest editorial in a recent issue of the Japanese periodical, *Plastics Industry News*. The list of plastics now made in Japan, that includes polystyrene, polyethylene, acrylics, and several other materials, is headed by PVC, production of which was 106,613 tons in 1957. Less than 10 years earlier (in 1949), total annual output of PVC had been a mere 188 tons.

Month to month figures for the period October 1957-February 1958, reveal a sharp decline in the first two months of the current year, which may or may not be an indication of over-production of PVC in 1957. For the last three months of that year, the figures are officially given as having been 8,198, 8,286 and 8,505 tons, respectively. For this year, however, the amount fell to 6,570 in January, and 5,967 tons in February.

It seems that many PVC resin manu-

Vital ingredients for the PLASTICS INDUSTRY

METASAP VINYL STABILIZERS

—designed to give better protection from heat and light. Whether you are producing film, sheeting, floor tile or plastisols, there is a Metasap Stabilizer to do the job.

METASAP METALLIC SOAPS

—these proven compounds not only improve internal lubrication of molding powders, but act as plasticizers. When dusted on molds, they supply external lubrication and prevent sticking. They also permit molding at lower pressures, help speed the molding cycle, promote longer mold life, improve the finish of the end product.

★ ★ ★

Remember, whatever your needs, you will fill them best—fill them fast—through Metasap. Write for full information. Our Technical Service Department will gladly make recommendations based upon your specific requests. Metasap Chemical Company, Harrison, N.J.

VITAL INGREDIENTS FOR THE PLASTICS INDUSTRY

A subsidiary of NOPCO ®

Harrison, N.J. • Richmond, Calif. • Cedartown, Ga.
Boston, Mass. • Chicago, Ill. • London, Canada

facturers now are producing low-molecular weight, easy processing, general-purpose resin. One company has begun to produce PVC of 800 molecular weight, and another of only 600. The latter material is intended for use in adhesives and the treating of fabric.

Mainland China reportedly is due to take some of Japan's PVC, since the statement was made, during a meeting of a Trade Mission from China with officials of the Japanese plastics organizations, that China expected to use 3,000 tons of PVC resin during 1958 and might import 1,000 tons from Japan.

Meanwhile, it is learned that Japanese Geon exported 82 tons of PVC resin to China mainland in April 1958. The material apparently was intended for the manufacture of pipe, and a Japanese-make extruder with screw diameter of 40 millimeters and an extrusion capacity of 15 kilograms per hour is understood to be awaiting shipment to China.

Incidentally, Burma has shown much interest in PVC pipe and is said to have bought 380 metric tons from Japan.

French Plastics Industry, 1957

According to figures compiled by J. Combette (*Industrie Plastiques Modernes*, May 1958), French production of plastics increased by 24% in 1957 as compared with 1956, the respective totals having been 155,920 and 128,030 metric tons. Some of the figures for individual plastics in metric tons, are given below.

	1957	1956
Cellulosics	6,970	5,630
PVC (dry resins)	52,200	40,600
Polyvinyl acetate	10,500	8,000
Polymethacrylics	1,470	1,250
Polyamides	1,600	1,550
Polystyrenes	19,480	17,120
Polyethylenes	6,200	5,600
Phenoplastics	18,270	15,700
Aminoplastics	14,430	13,180
Silicones (commercial forms)	600	380
Epoxy Resins	400	...
Polyesters	4,000	2,420

It will be seen from this table that the largest percentage advances were made by polysters, silicons, and PVC, in that order. Production of polyester resins began in 1954 with a total of 70 tons, and rose to 910 tons in 1955; a further substantial increase during 1958 is looked for. The manufacture of epoxy resins was started in France for the first time in October 1957, and the figure given, 400 tons, is an estimate.

Consumption of plastics by the French industry rose from 159,339 metric tons in 1956 to 194,342 metric tons in 1957. Some details are presented in the following table:

	1957	1956
Cellulosics	8,738	6,578
PVC	50,630	38,044
Acetals, alcohols, PVA, polyvinylidene chloride	11,000	10,590
Polyacrylics	2,758	2,346
Polyamides	1,600	1,515
Polystyrenes	22,290	20,005
Phenoplastics	21,600	20,474
Polyethylene	24,300	17,600
Aminoplastics	25,134	21,150
Silicones	300	250
Polyesters	4,000	2,500
Epoxies	950	534
Polyfluoroethene	30	25
Polyurethanes	112	38

Imports of plastics in 1957 came to 50,758 tons, the major customers, providing 80% of the total, were the United States, with 15,976 tons (including 10,378 tons of polyethylene and 1,625 tons of polystyrene); Germany, with 13,777 tons (5,433 tons of amino-plastics, 3,869 tons of vinyl resins, and 1,141 tons of polystyrene); and Britain, with 10,794 tons (6,051 tons of polyethylenes and 1,925 tons of aminoplastics).

Exports were up slightly to 13,362 tons in 1957, thanks largely to a substantial rise in exports of polyamides (chiefly for the textile industry) that made up for the drop in PVC sales abroad.

French injection molders had a minimum of 5,932 machines in use by the end of 1957, of which 1,118 were installed during that year. The capacities of most machines was in the ranges of 20-80 and 120-160 grams. In all, there were 15 of the largest machines with capacities from 2,000-8.000 grams.

Australia to produce Styron

A new plant is being built in Thodes, New South Wales, by the C. S. R. Chemicals Pty., Ltd., for the production of a new, high-impact polystyrene under license from the Dow Chemical Co., Midland, Mich. Dow is making technical know-how available, and the Rhodes installation is expected to produce enough of the material to cover all Australian requirements.

Recent French Developments

Phillips-type linear polyethylene, to be marketed as Manolene, soon is to be produced on an industrial scale in a plant near Le Havre, France. The Manufacture Normande de Polyethylenes, a company formed jointly by the Compagnie Francaise de Raffinage, Etablissements Kuhlmann, and the Societe Rhone-Poulenc, has obtained exclusive rights from Phillips to exploit the relevant processes in France.

Etablissements Kuhlmann is marketing four grades of polystyrene, known as Lorkalenes. Lorkalenes 3 and 8 are standard polystyrenes, the former being intended for general purposes, while the latter has improved mechanical properties. Lorkalenes 300 and 800 are special impact-resistant grades. Some values for Lorkalenes 8 and 800 are shown in the following table:

	Lorkalene 8	Lorkalene 800
Tensile strength, kg./sq.cm.	595-660	380-520
Modulus of elasticity, kg./sq.cm.	28,000-35,000	24,000-28,000
Flexural strength, kg./sq.cm.	900-1,050	560-66
Heat distortion temperature, °C.	94	91
Izod impact resistance	0.25-0.45	0.8
Rockwell hardness	76-80	20-30
Water absorption in 24 hours, %	0.05	0.08

All types are supplied either with or without external lubrication, as desired.

New Materials

Write item numbers on Readers' Service Card to obtain more information.

Epoxy Casting Resins

Four additional, two-step, epoxy casting resins have been added to the Hysol 6900 series manufactured by Houghton Laboratories, Inc. Designated Hysol 6905-6908 inclusive, the compounds incorporate the high electrical properties common to epoxies; offer outstanding resistance to thermal shock; are easily handled, and have a long pot life.

When mixed according to the manufacturer's recommendations, a cure is obtained in four hours at 100° C., or two hours at 130° C. While low viscosity obviates the need for deaeration, a vacuum of approximately 28-inches Hg. may be used where intricate molds or exceptionally high performance requirements dictate the complete removal of air.

The Hysols are quite flexible as indicated on the Izod notched impact test, where samples of the four materials produced energy losses greater than four foot-pounds upon breakage.

These resins conform to thermal tests for MIL-16923B and MIL-T-27A and exhibit the following physical properties:

	6905	6906	6907	6908
Mixing ratio by weight, A to B	100/160	100/170	100/110	100/120
Specific gravity	1.05	1.05	1.45	1.45
Gel time at 100° C., min.	60	60	60	70
At 130° C., min.	20	20	20	20
Weight loss, 2,000 hrs., 175° C., %	5.08	8.06	2.68	4.66
Water absorption, 24 hrs., %	0.33	0.41	0.26	0.33
Dielectric constant, 1 mc.	3.08	3.25	3.70	3.82
Power factor, 1 mc.	0.0371	0.0425	0.0309	0.0398
Volume resistivity, initial, 130° C., ohm-cm. x 10^9	8.3	8.0	1.9	1.9
After 2,000 hrs., 130° C., ohm-cm. x 10^{13}	1.3	2.7	1.9	1.1
Dielectric strength, volts/mil.	400	400	400	400
Linear shrinkage, in./in.,				
100° C. cure	0.018	0.018	0.010	0.010
130° C. cure	0.025	0.025	0.015	0.015
Tensile strength, psi.	1,500	1,400	1,950	1,800
Hardness, Shore D, instantaneous	60	45	60	45
After 10 sec.	45	30	45n	30
Elongation, %	135	150	90	100
Thermal expansion coeff. x 10^{-5}	14.1	19.7	7.8	11.6

Readers' Service Item 110

Electrical Grade Plasticizer

An electrical grade plasticizer which also can be used for dispersion compounding to impart low viscosity to plastisols, is being made in commercial quantities by Rohm & Haas Co. Called Monoplex S-90, this material can be compounded with vinyl or copolymer resins to make insulation having high initial electrical properties and excellent retention of same even after exposure to severe aging conditions.

Unlike other plasticizers of comparable permanence, Monoplex S-90 does resist micro-organism attack, a feature which previously could be obtained only with certain phthalate and phosphate esters. Insulation materials meeting the demands for 105° C. service as well as requirements for various high temperature military specifications also can be formulated. When compounding for good aging characteristics, use of an antioxidant, notably Bisphenol A, is recommended at a minimum level of 0.5% of the amount of plasticizer used. Test formulations comprising PVC resin, Bisphenol A, and Monoplex S-90, along with a stabilizer and a lubricant showed significant increase in both dry and wet volume resistivity readings over similar formulations without the antioxidant.

Compounds in which this plasticizer is incorporated exhibit good compatibility characteristics and no corrosive effects on copper. With respect to volatile loss, oil, water, and soapy water extraction, it is superior, to common monomeric esters and excelled only by high molecular weight polyesters. A summary of its physical properties follows:

Specific gravity, 25° C.	1.005
Color, varnish scale, max.	2
Viscosity, Gardner-Holt, 25° C.	E-G
Refractive index	1.4514
Solidification point, °C.	—55
Acid number, mgm. KOH/gm., max.	0.2

Readers' Service Item 111

Two Vinyl Stabilizers

Two vinyl plastisol stabilizers, Ferro 1701 and 1720, which give good early color retention as well as light and light stability, are available from Ferro Corp. The former is a barium-zinc type, while the latter includes cadmium as well.

Ferro 1701 is recommended as a one-package stabilizer for use with pigmented and filled plastisols. Its high efficiency per-

HAVE YOU TRIED

LOW COST MICA FLAKES For REINFORCING?

Increased electrical insulation. Compatible with all types of resins. Stocks in principal cities.

U. S. MICA CO., INC.

79 PROSPECT ST.
STAMFORD, CONN.

mits one or two PHR to be used for most processing operations, although higher concentrations can be formulated. Ferro 1720 is designed for casting, molding, or coating of clear or pigmented and filled plastisols. Optimum concentrations of this material must be determined for the particular processing operation involved.

Both materials are amber liquids and have a toxicity normal to barium compounds. They are compatible with epoxy plasticizers, have good air release properties, and are non-sulfur staining.

Readers' Service Item 112

Two Epoxy Casting Systems

Two epoxy resin casting systems known as Isocast 405 and 441 have been placed on the market by Isochem Resins Corp. The former is mainly for high-temperature and general-purpose use, while the latter incorporates an adjustable flexibility feature.

Isocast 405 contains a mineral filler and is free of solvents, reactive diluents, and other degrading adulterants. It is used with a low toxicity hardener that converts the resin to a "B" stage solid at room temperature giving off a minimum of exothermic heat. The "B" staged resin then is cured at low temperature to achieve Class H properties, i.e. 180-200° C. service. A black liquid containing 100% solids, Isocast 405 when cured gives excellent adhesion, chemical resistance, and machinability, as well as good mechanical strength. The catalyzed system has a working life ranging from 6-16 hours.

Isocast 441 is a two part system recommended for sealing, potting, and encapsulation of electrical components. Properties of the cured material can be varied from a semi-rigid hard casting to a rubber-like flexible sealant simply by varying the proportion of its parts. The compound may be cured at room or elevated temperatures.

Typical physical properties of the cured resins are summarized as follows:

	Isocast 405	Isocast 441
Specific gravity	1.3	1.25
Tensile strength, ultimate, psi	14,000	32,000
Compressive strength, psi	18,000	—
Flexural strength, psi	15,500	50,000
Impact resistance, Izod, ft. lb./in.	0.3	9
Dielectric strength, volts/mil	480	440
Constant, 10^6 cycles	4.4	3.1
Volume resistivity, ohm-cm	2×10^{15}	1.2×10^{14}
Power factor, 10^6 cycles	0.017	0.01
Operating temperature range, °C	—60 to 200	—60 to 140

Readers' Service Item 113

Epoxy Resin Modifier

An organophosphorous modifier which accelerates cure rate and maintains or improves physical and electrical properties of epoxy resins, has been introduced by Monsanto Chemical Co.'s organic chemicals division. Trade-named Mod-Epox, the modifier is liquid at room temperatures and has a low order of toxicity.

Substantially cheaper than glycidyl ethers, Mod-Epox imparts dimensional stability, plus chemical and water resistance characteristics which are superior to those obtained with resins systems using other modifiers. The low initial viscosity of the treated system permits use of larger amounts of fillers without lowering the quality of the finished product.

While a 25 PHR modifier-resin ratio is recommended for optimum physical properties, the modifier's complete compatibility and miscibility permit many formulations for specific properties. Physical properties of several resin systems treated with Mod-Epox and other modifiers are compared as follows:

	Control	I	II	III	VI
Formulation in PHR:					
Liquid epoxy resin, (E.V. 200)	100	100	100	100	100
Mod-Epox		25	25		
Allyl glycidyl ether				10	
Butyl glycidyl ether					13.5
Diethylene triamine	12	8	11	13	13
Properties:					
Viscosity, cps., 25° C.	1650	920	620	450	420
Hardness, Rockwell M.	102	103	93	90	90
Heat distortion pt., °C.	114	74	78	83	76
Compressive yield strength, psi.	15,550	16,500		14,100	13,250
Water absorption, % in 7 days	0.40	0.38	0.58	0.50	0.52
10% caustic absorption, % in 7 days	0.31	0.32	0.54	0.40	0.42

Readers' Service Item 114

VANSTAY®

Vinyl heat and light stabilizers

Our trade mark of 12 years standing came into being with VANSTAY L, the first nontoxic light stabilizer for Vinyls.

Today, the VANSTAY line includes a number of materials developed to keep pace with Industry's demands for higher temperature Vinyl protection in process and in service.

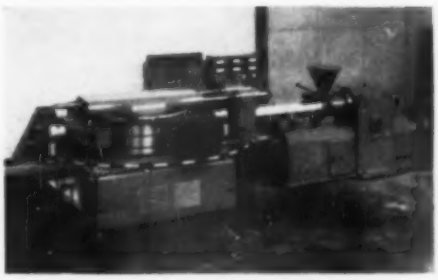
Expanded research and technical service can be of immediate assistance in solving your Vinyl stabilization problems.

R. T. Vanderbilt Co., Inc.

230 PARK AVENUE · NEW YORK 17, N. Y.

New Equipment

Write item numbers on Readers' Service Card to obtain more information.



Extr-a-formatic extrusion injection machine.

Extruder-Molder Combination

A new-type injection molding system, incorporating an extruder that discharges into one of several molds carried on a rotating carousel, has been developed by Paul Troester Maschinenfabrik, Hanover, Germany. Called Extr-a-formatic, the machine is being marketed in this country by Continental Machinery Co.

The carousel, which is powered hydraulically, bears up to 24 molds. During operation the table is actuated by electromagnetic control valves which, in turn, are controlled automatically by adjustable cams. The arrangement and adjustment of the cams depend on the number and position of the molds so that each moves into register with the extruder orifice to receive the shot. Injection time is controlled automatically by a time-limit relay and is adjustable between 1½-30 seconds.

An automatic mold-opening mechanism is located diametrically opposite the injection side of the machine. This mechanism incorporates a holder which engages locking pins on the mold caps. The motion which brings one mold into register with the extruder orifice causes the opposite one to open. After the mold is opened, the cap is removed automatically to a sufficient distance so that its contents may be removed easily. Opening time is dependent on the duration of injection plus the molding time of the opposite mold. Closing takes place automatically in a reversed sequence of operations caused by the next angular motion of the table.

Both the hydraulic actuating unit and the heating and cooling system components are located in an easily accessible position beneath the rotating table. The temperature-control medium is supplied to the molds through flexible tubes by means of an electric circulating pump. Temperatures are regulated automatically by a thermostat.

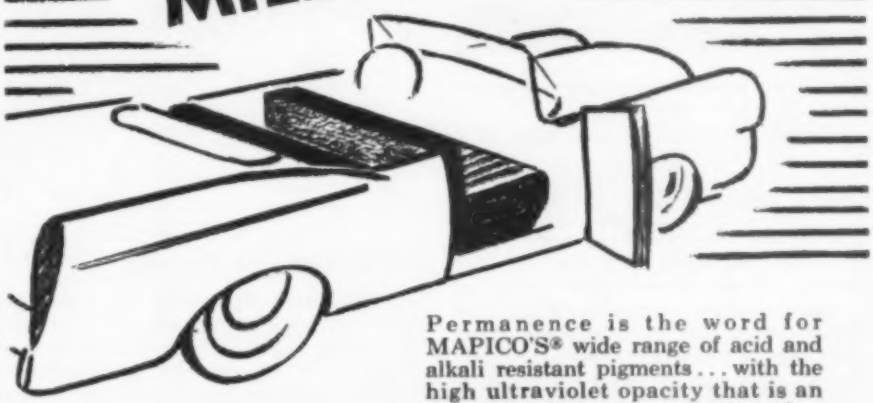
The extruder head communicates with the several molds through a front-plate, secured by four stay-bars to the center, stationary, part of the carousel. Depth of mold which may be used varies between 400-650 mm., and a compensatory adjustment of the front-plate can be made in a longitudinal direction. The table is mounted on rails and, if desired, may be disconnected and withdrawn so that the extruder can be used for other operations.

The use of an extruder results in quicker, more uniform heating, and produces a thorough homogenizing effect which permits lower closing pressure or, alternatively, larger projected mold areas. High volumetric efficiencies are obtained since the plasticizing capacity of the unit is not affected by extended stoppages and lengthy cooling periods.

Available with a choice of two extruder models, EP 90 and EP 120, the Extr-a-formatic is controlled automatically from a switch cabinet containing time limit and temperature relays. If necessary, the unit may be placed on hand-control and operated by push-buttons also located in the cabinet. Operational characteristics of this machine are as follows:

"Colloid Corner" by COLUMBIAN

Upholstery Colors that will last a MILLION MILES!



MAPICO Synthetic Iron Oxides are so light-fast and chemically stable they can resist weather literally for centuries.

Permanence is the word for MAPICO'S® wide range of acid and alkali resistant pigments . . . with the high ultraviolet opacity that is an important factor in preserving plastics. MAPICO colors can take years of exposure to intense sunlight . . . in automobile upholstery, coated textiles, roofing, plastic flooring, luggage stocks and endless other materials.

And the wide range of MAPICO colors includes combinations with special characteristics . . . utterly uniform . . . dependable in performance, because they are synthesized in modern factories under precise, exacting controls.

Select the MAPICO pigment best suited to your needs—in completely stable reds, yellows, tans, browns or blacks—and you will be supplied promptly from a coast-to-coast network of warehouses. For any questions or technical assistance on your proposed application...write...today!

For Progress in Colloids

COLUMBIAN CARBON COMPANY

380 Madison Avenue, New York 17, N. Y.

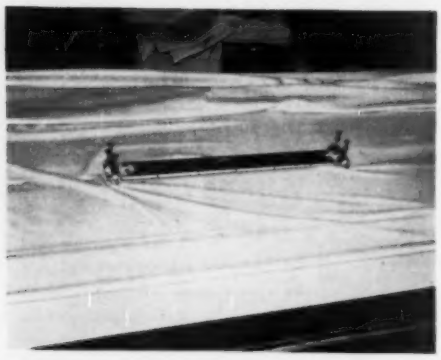
CARBON BLACKS • SYNTHETIC IRON OXIDES • DISPERSIONS

COLUMBIAN Carbon Blacks are available in three forms: POWDER • BEADS • DISPERSIONS

New Equipment (Cont'd.)

Plasticizing cap., kg./hr., EP 90	120
EP 120	250
Injection cap. mold, max., cm.^{3}	2,500
Pressure, kg./cm.^{2}	300
Mold closing pressure, metric tons,	250
Opening pressure	30
Area, max., cm.^{2}	200
Depth of molded piece, max., mm.	500
Gear pump pressure, atmospheres	90

Readers' Service Item 115



Heat sealing table showing upper keeper in position on plastic sheet material.

Heat Sealing Table

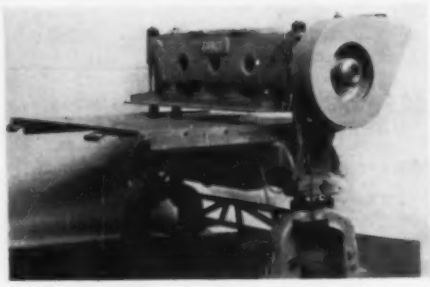
Fabrication of swimming pool liners, silo covers, and other large area products requiring plastic sheet material can be facilitated with use of a heat sealing table recently introduced by Electronic Processes Corp. of California. The device employs an eight-foot slotted table, a 2-KW high frequency generator, and a 36-inch magnetic bar sealing electrode.

The high frequency generator, whose RF radiations are within the minimum FCC requirement, is power-driven along rails located directly beneath the table top. Sealing is accomplished by first positioning the sheet on the table, placing an upper keeper over the electrode, and pushing a button to start the sealing cycle which terminates automatically. Depressing a second button drives the generator and electrode a predetermined distance along the rails where the sealing cycle is repeated. The electrode arrangement permits lap-welding which produces a seam stronger than the material itself. Additional eight-foot table sections can be added as desired.

Readers' Service Item 116

Die Cutting Press

A four-poster die cutting press, exerting pressures up to 45 tons, has been added to the product line of Atlas-Sandt Corp. Designated Sandt ST 76/A Pontus model, this machine is especially useful for cutting large sheet blisters, trimming of vacuum formed items, and for standard sheet cutting operations.



Sandt ST 76/A Pontus die cutting press.

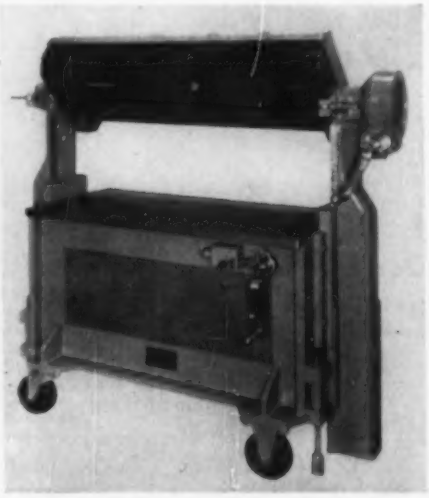
Pressure plates measuring 61 by 24, or 61 by 34 inches can be accommodated. Appropriately sized work tables are provided, and for very large jobs, a double sliding table measuring 61 by 80 inches can be obtained. For ease of operation, these tables slide on ball bearings. The unit delivers one- or two-inch cutting strokes and is V-belt driven by a 4-hp. motor. Operators are protected by a two-hand, electromagnetic safety release.

Readers' Service Item 117

Motorized Die Handler

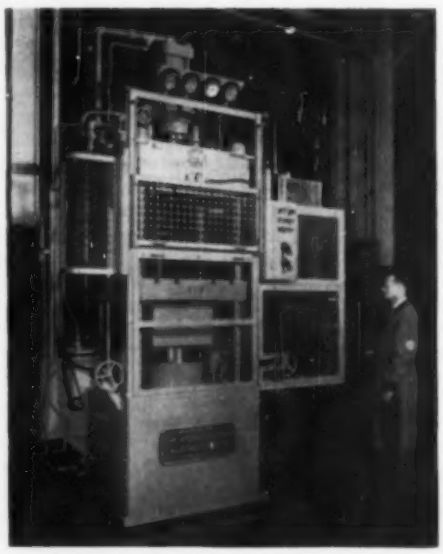
A motorized die handler for separating plastic molds, punch press dies, and similar devices is being marketed by Hansford Mfg. Corp. The unit obviates the use of a chain hoist and lead mallet, and is said to save up to 100 hours on an average die-making job.

The cast iron top platen is supported by uprights that move in scraped V-ways in the saddle casting. Rapid lift is provided through lead screws actuated by an electric motor, while fine adjustments are made by means of a hand crank which functions independently. The motor control switch incorporates a safety device that prevents its operation while the hand crank is engaged and, in like manner, the hand crank cannot be engaged when the switch is in the "up" or "down" positions. A hand crank, in combination with a gear reducer and a set of spiral bevel gears, rotates the top platen through an angle of 360°. Both the platen and the fabricated steel base are machined to very close tolerances.



Hansford Model 1015 die handler.

Readers' Service Item 118



HPM 100 ton transfer molding press.

Transfer Molding Press

A 100-ton, upward-acting, semi-automatic, transfer molding press, equipped with a top-mounted transfer cylinder, has been designed by Hydraulic Press Mfg. Co. This unit incorporates automatic loading, feeding, and preheating equipment, and is powered by a 15-hp. motor driving variable displacement hydraulic pumps.

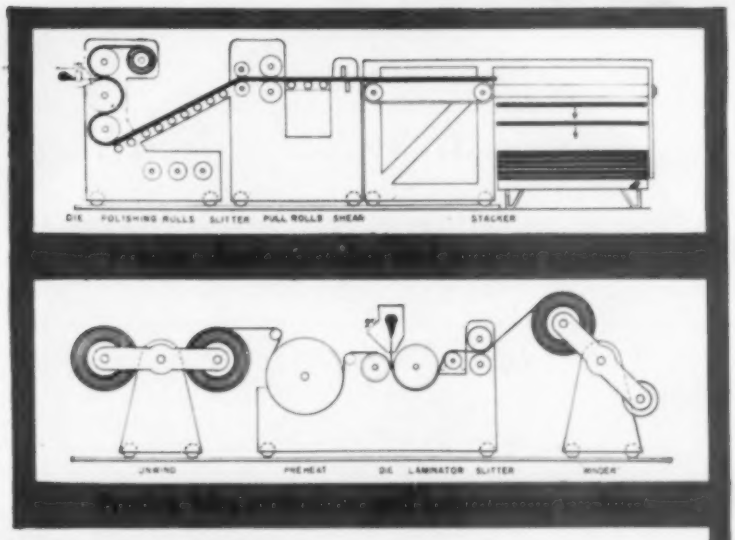
Finished parts are ejected by a 10-ton hydraulic ejector system which is built under the moving platen. The clamp stroke is adjustable at any point. Other specifications for this model include:

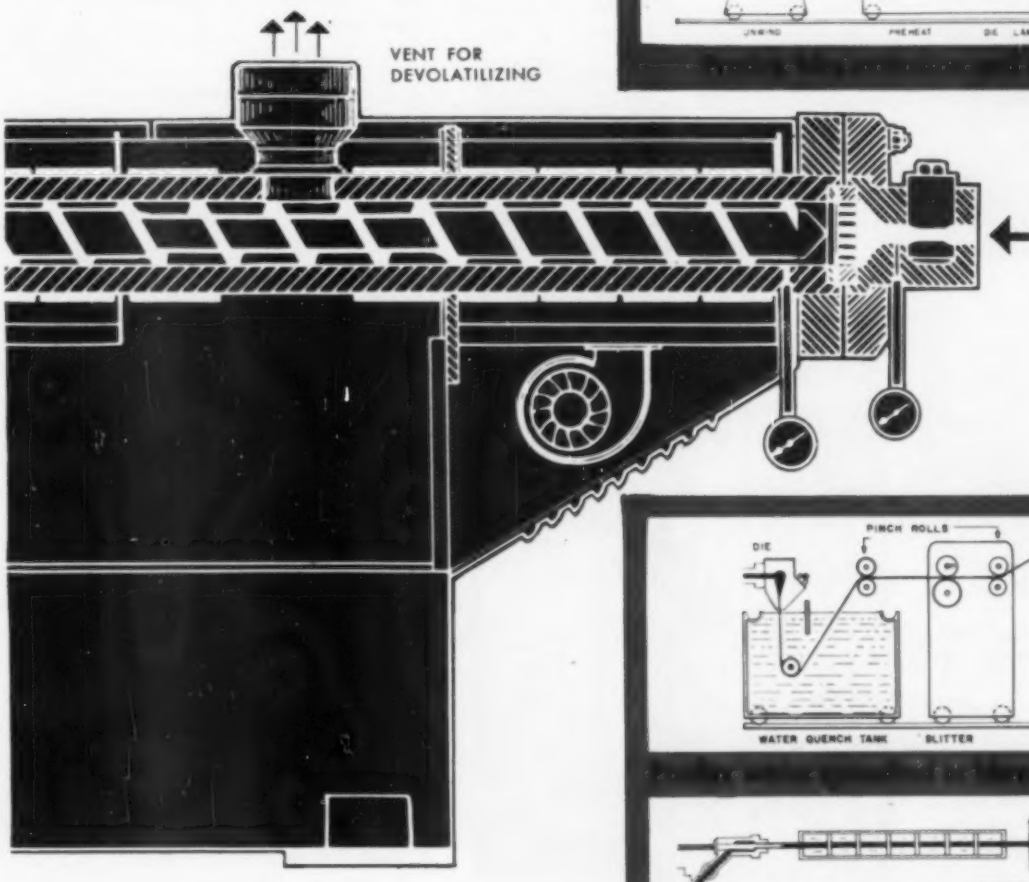
Transfer cylinder pressure, tons, max.	25
Min.	8
Grid dimensions, in.	36 by 16
Platen dimensions, in.	36 by 16
Clearance between stain rods,	
front to back, in.	17
Left-to-right, in.	26.75
Daylight opening, platen-to-head, in.	30
Platen-to-upper grid, in.	25
Stroke length, in.	12
Weight, lbs.	24,600

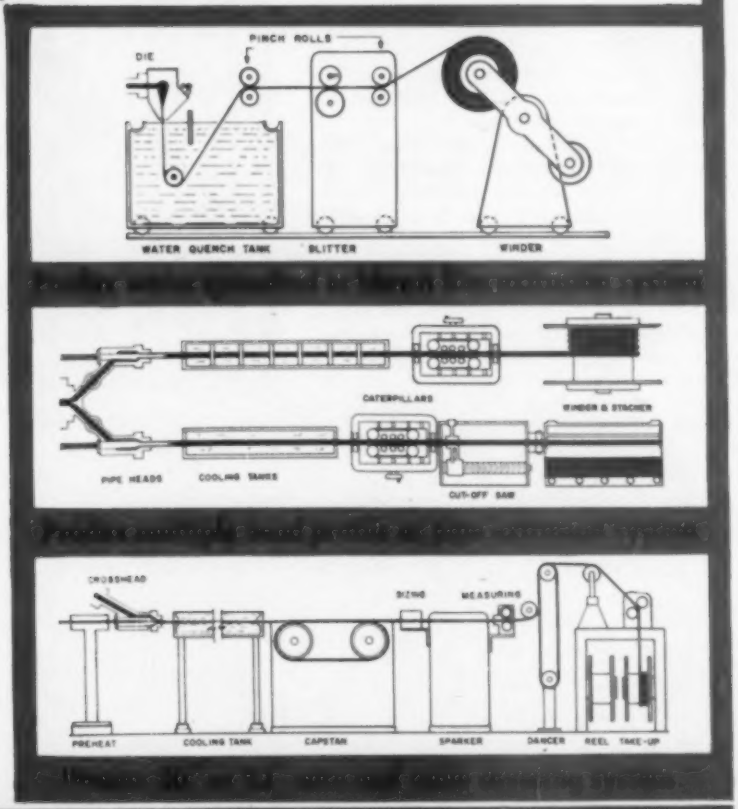
Readers' Service Item 119

PRODEX EXTRUSION and COMPOUNDING SYSTEMS

the last word in Plastics Extrusion Technology.







Designed for easier, more automatic operation and for faster capital return.

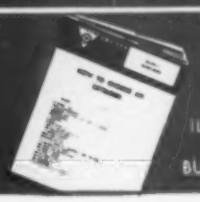
PRODEX

PRODEX CORPORATION

FORDS, NEW JERSEY · HIllcrest 2-2800

Manufacturers of Process and Extrusion Machinery

IN CANADA: Barnett J. Danson & Associates, Ltd., 1912 Avenue Road, Toronto 12, Canada



ASK FOR 50 PAGE ILLUSTRATED BULLETIN E-3

Plastics Applications

Write item numbers on Readers' Service Card to obtain more information.

Exterior siding of Terox stone.

Great Stone Face!

An imitation stone facing made of Reichhold Chemicals' Polylite polyester resin reinforced with Owens-Corning Fiberglas has been placed on the market by Terox Corp. of America. Light-weight and waterproof, the Terox simulations faithfully reproduced the texture and contours of the quarried stone from which their mold-dies have been cast.

Made in four foot square panels measuring approximately 48 by 12 inches, the veneer is nailed on to provide interiors and exteriors where structural limitations make the use of real stones impossible or impractical. When all the panels are nailed in place, the recessed areas between them are filled with an all-weather compound to seal the joints.

Terox is available in two colors: New Bedford Gray, which resembles Lannon stone; and Sierra Blend, resembling Tenessee cut stone. Permanent pigments are blended directly into the resin, and the panels will not crack, craze, chip, or crumble. Each panel weighs four pounds and contains seven stone-impressions in various shapes.

Readers' Service Item 120

Wood-Plastic Folding Door

Vertical mahogany slats laced together with nylon-reinforced vinyl tape to form a low-cost folding door or room divider have been introduced under the trade-name Wovynfold, by American Accordian-Fold Doors, Inc. Ideal for the economy minded builder or home owner, the units are available in gray, beige, white, and natural tones to complement any interior design motif.

Easily installed, the door has an almost indefinite working life. It slides on molded nylon runners along a steel track, and in simulated operating tests more than one million closures were made without appreciably affecting its operation or structure. A metal female latch, attached to the lead rail, mates with a male latch installed on the door jamb.

Complete visual privacy and dust stoppage is afforded when the door is closed. In the opened position it reduces to a folded stack about 4¼ inches wide and less than 12% of its extended length. Available in 11 stock sizes beginning at 26 by 80 inches, Wovynfold doors can be shortened to any length for intermediate fits.

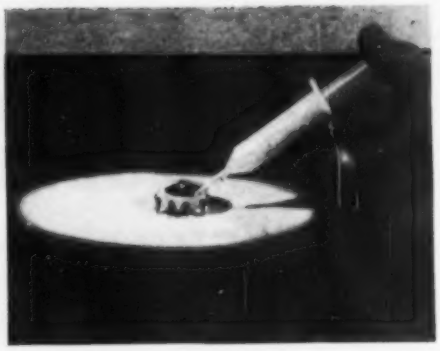
Wovynfold sliding door.

Readers' Service Item 121

Polyethylene Syringe

Application of bonding agents, potting compounds, and adhesives can be facilitated with a disposable polyethylene syringe recently developed by Carl H. Biggs Co. Marketed under the firm's 'Helix' tradename, the unit dispenses precise amounts of fluid without dripping, flooding, or starving.

Each syringe weighs ½-ounce, and has an approximate 10 cc. fluid capacity. Tips are tapered so that orifice diameters may be enlarged to compensate for viscosity variations. For fine work, such as ceramics decoration, the units can be furnished with blunt-end, 1½-inch steel, hypodermic type needles.



Biggs disposable polyethylene syringe.

Readers' Service Item 122

Extruded Patterned Paneling

A recent introduction of Rotuba Extruders, Inc., Extru-Lite R1, is finding added acceptance as a room or office dividing panel. Originally developed for the lighting industry as a fluorescent light diffuser, its pyramid-shaped prisms break up light rays from a concentrated source thereby removing glare. Light transmission rates of 70% are reported for a 1/8-inch thick panel.

Extru-Lite can be extruded in different materials; the standard plastics used by Rotuba being high heat- and ultraviolet light-stabilized styrene and acrylic. Clear in color, the paneling derives its opacity through the prismatic configuration on one side. This feature makes it useful for enclosed shower doors and Shoji screens. At present, two thicknesses are being manufactured: 1/8- and 3/16-inch, the former weighing but 0.58-pound per square foot. In addition more break-resistant, it weighs less than half as much as glass.

A one- by four-foot Extru-Lite panel contains over 30,000 prisms, more than twice as many per square inch as competing paneling. Normal cleaning schedules call for the use of water plus a mild detergent.

Readers' Service Item 123

Reinforced Plastic Ladder

A non-conducting, fibrous glass-reinforced polyester ladder was recently introduced on the West Coast by Hopfeld Industrial Mfg. Co. Straight and extension ladders up to 28 feet in length are made on a special press using glass-reinforced Polylite polyesters supplied by Reichhold Chemicals, Inc. Rungs are bonded with RCI 6140 Polytool epoxy resin. Both rungs

and side rails are hollow, except for a W-shaped core, and the side piece measures one by three inches—small enough to provide an easy hand grip.

The extension models have a specially designed lock which the manufacturer claims to be superior to any extension ladder lock on the market. This lock snaps automatically onto a rung when the rope is released. Tension on this rope acts as a brake during lowering. Sand-like particles are imbedded into the rung as an anti-slip feature.

In a series of tests to determine break- and splinter-resistance, the ladders were dropped repeatedly its full length onto a sawhorse with no more than surface scratching. In still other tests it reportedly demonstrated over-all superiority to both wooden and aluminum ladders. Weighing about 1½ pounds per foot, the ladders require no maintenance and will not sag or lose shape in use or storage.

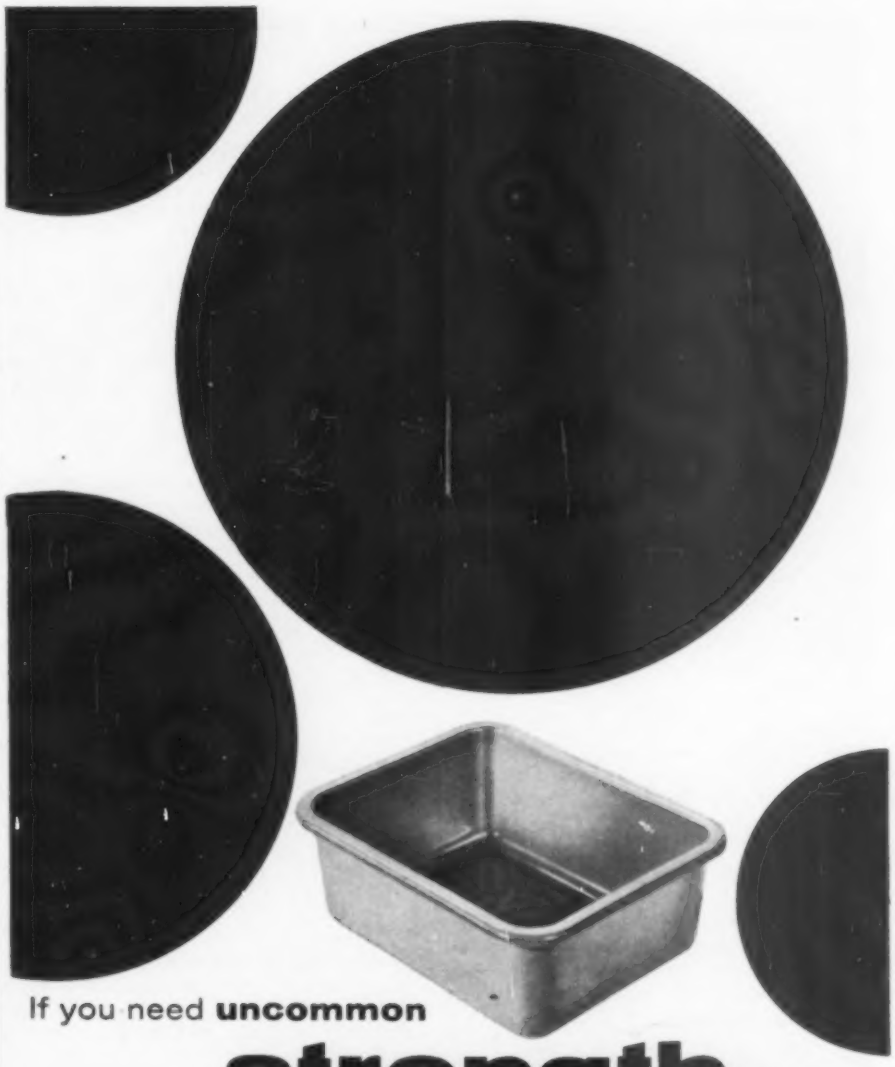
Reinforced plastic ladder is both light and steady.

Readers' Service Item 124

The 7-10 Split, No Timber

Bowling enthusiasts will welcome a home bowling set whose components will neither scratch nor mar hardwood floors and furniture. The pins are blow molded from Du Pont's Alathon 10 polyethylene resin by Perfection Packaging Co., while the balls are two-piece, acetate butyrate, injection moldings. Currently being marketed by Transogram Co., the pins come in six sizes measuring in inches: 6, 7, 8, 9, 10, 11, and 13. Each set contains 10 pins, two balls, and a spotting mat.

Readers' Service Item 125



If you need **uncommon**

strength...

make it with **GREX*** HIGH DENSITY POLYETHYLENE

Strength and sales appeal are twin imperatives in today's highly competitive housewares market . . . and GREX high density polyethylene gives a brand new measure of both!

This colorful dish pan, for example, is tough and rigid, can hold boiling water, will not warp, resists detergents and bleaches, and keeps its high gloss and attractiveness.

This same plastic makes crisper-trays, food containers and tumblers that never turn brittle, never shatter when frozen, and are easily cleaned.

These very qualities of durability recommend GREX for a limitless variety of uses: refrigerator parts that stand up under heavy loads and cold temperatures; sterilizable bottles; canisters and cups that don't break; automotive parts . . . toys . . . furniture drawers. You name it, and we'll show how *this versatile plastic means better products for you.*

*Trademark for W. R. Grace & Co.'s polyolefins. W. R. Grace & Co. produces GREX resin for a wide variety of uses, does not make the finished articles mentioned above.

W. R. GRACE & CO.
POLYMER CHEMICALS Division
OFFICES: CLIFTON, N.J. CHICAGO, ILL. PLANT: BATON ROUGE, LA.

New Literature

Write item numbers on Readers' Service card to obtain copies.

"Xaloy Bimetallic Extruder Cylinders." Industrial Research Laboratories, division of Honolulu Oil Corp. 16 pages. Specifications are listed for Xaloy and Xaloy 306, respectively, ferrous and non-ferrous alloys used for lining extruder barrels. The former offers exceptional wear resistance, and the latter offers both corrosion and wear resistance. Xaloy-lined cylinders can be engineered for adaption to newly-designed equipment, or as replacements in existing machines.

Readers' Service Item 126

"Spin the Dial." Union Carbide Chemicals Co. The solvent selector wheel enables a user to pick the right solvent, diluent, or coupler for coating formulations.

Readers' Service Item 127

"Hysol." Houghton Laboratories, Inc. 28 pages. A compilation of Hysol bulletins, it describes these epoxy tooling materials, shows how to make patterns, and lists data and prices.

Readers' Service Item 128

"Ger-Pak Agri-News." Gering Products, Inc. 4 pages. The first of a series of bulletins to be issued by Gering, this particular issue describes a polyethylene greenhouse and explains how it is made.

Readers' Service Item 129

"Corvel Fusion Bond Finishes." National Polymer Products, Inc. 4 pages. Corvel cellulosic, nylon, polyethylene, K-51 chlorinated polymer, and other dry powders which are used in the Whirlclad coating of metal parts are described in this bulletin.

Readers' Service Item 130

"They Both Do the Same Job but at Different Costs." Mead Corp. 4 pages. Described herein are Mead's Chestnut Poke-Pak and Glide-Pak pallets for materials handling.

Readers' Service Item 131

"Wear—Usure—Verschleiss, An International Journal on Fundamentals of Friction, Lubrication, Wear and Their Control in Industry." Elsevier Publication Company, Amsterdam, Netherlands, Vol. I. 1957/58.

The aim of this journal, as the sub-title indicates, is to report basic research on friction, lubrication, and wear, as well as the application of the results to industry. The first four issues (August, October, December 1957, and February 1958) contain original papers as well as critical review articles dealing with frictional properties and wear-resistance of metallic, organic, and inorganic materials under laboratory and working conditions. They are written in English, French and German by experts from Australia, Japan, India, the Soviet Union, the United States, and Europe. There also are abstracts of current literature and brief reports on current events.

Readers' Service Item 132

"Atlas Plastics." Atlas Plastics, Inc. 4 pages. Detailed information is given on the firm's facilities for matched die molding, vacuum bag molding, contact molding, and tube wrapping of Fiberglas-reinforced parts.

Readers' Service Item 133

"Briskheat Heating Jackets and Heating Tapes." Burrell Corp. 8 pages. This 1958 catalog introduces a new line of heating jackets for practically every type of container used in the laboratory and pilot plant.

Readers' Service Item 134

"Our Lips Are Sealed." Evans Research & Development Corp. 4 pages. The folder outlines 10 types of plastics research work done by Evans, and explains how the firm can help in developing new and improved products.

Readers' Service Item 135

"Ace Fabricated Plastic Parts." Ace Plastics Co. 2 pages. This illustrated circular shows the different shapes and forms available from the company.

Readers' Service Item 136

"Structural Sealing with Elastomeric-Type Sealants Based on Thiokol Liquid Polymers." Thiokol Chemical Corp. 12 pages. The booklet features case histories on curtain wall installations using elastomeric sealants, which are said to be effective for the life of the building. Handling and methods of application are covered.

Readers' Service Item 137

"What SPE Can Do For You." Society of Plastics Engineers, Inc. 16 pages. Activities and benefits of the Society of the Plastics Enginers, Inc., are summarized in this bulletin.

Readers' Service Item 138

"Fire Hazards of Welding and Cutting in the Plastics Industry." Society of the Plastics Industry, Inc. 4 pages. Case histories of welding fires in the plastics industry are cited, along with general hazards and methods for preventing these fires.

Readers' Service Item 139

"Organic Chlorine Compounds." Union Carbide Chemicals Co. 45 pages. The booklet details physical and physiological properties of 11 such materials, lists uses, and gives storing and handling information.

Readers' Service Item 140

"Manifolds for Gases." Catalog 829. Air Reduction Co., Inc. 20 pages. Information is given on cylinder capacity, arrangements, and dimensions; plus data on the advantages of manifolding.

Readers' Service Item 141

"The Richardson Select-O-Weight System." Bulletin 0557. Richardson Scale Co. 6 pages. This illustrated brochure explains how the remote control panel affords automation in continuous or batch processing, including record keeping.

Readers' Service Item 142

"Hi-Dri Unit." Thoreson-McCosh, Inc. 1 page. A mechanical dehumidifier designed for use with the company's hopper dryers, the unit is used with extremely hygroscopic materials under high humidity conditions.

Readers' Service Item 143

"How To Slush-Cast Molds for Epoxy Encapsulation." Bulletin G6. Cerro de Pasco Sales Corp. 4 pages. This bulletin describes how Cerrotru, a low-melting bismuth-tin alloy is used for accurate and inexpensive dip or slush-cast molds. These, in turn, are employed for encapsulating electronic components with epoxy resins.

Readers' Service Item 144

PLASTICS ARE A FAMILY AFFAIR

SHE WON'T SETTLE FOR COLOR-DRIFT DRAPES

There are many women in your life if you're calendering curtains. And they don't realize – or care – how touchy that thin-gauge job was for you. But you can bet they won't go along with two drapes out of the same box which show color drift.

The **ADVANCE Advastab BC-100** stabilization system provides excellent long-term heat and light stability . . . as well as maintenance of early color . . . for your product. By itself, **BC-100** goes a long way toward eliminating color drift. Clarity is excellent. Cost of the material is less than anything comparable to it. Add **ADVANCE** zinc stabilizer **Z-8 WW** and you extend all the advantages of **BC-100** itself – plus gaining H_2S stain resistance.

The **BC-100** system – balanced and tailored to the job – can solve almost any of the problems associated with stabilization – whether it be calendering, extrusion or plastisols. Very important, too, with this system stabilizer costs usually drop over 10%.

When your system contains zinc you'll of course want to consider the inclusion of **ADVANCE**'s epoxy plasticizer, **Plastoflex ESO** . . . insurance against any sudden degradation of the vinyl compound . . . provision for low migration and extractability.

Let's talk about your stabilizer system. Let's talk about saving you money! Samples, data and our technical development staff are at your disposal. For a comprehensive listing of other **ADVANCE** products see our insert in the Chemical Materials Catalog. Write or call. And if you telephone we have always assumed you felt free to do so collect.

The above mentioned stabilizers and many others, including a full line of organo-tins such as **T-52N, T-17M** and **T-72**, are available from **ADVANCE SOLVENTS & CHEMICAL**, 500-3 Jersey Avenue, New Brunswick, New Jersey . . . and from . . .

Advance International Ltd.,
245 Fifth Avenue, New York 16, New York
Advance Solvents & Chemical
Corp. of Canada, Ltd.,
Montreal and Toronto

and from our Manufacturing Affiliate . . .

Deutsche Advance Produktion G M B H
Marienberg Bei Bensheim
(Bergstrasse)
Western Germany

DIVISION OF CARLISLE CHEMICAL WORKS, INC.

ADVANCE

Plandex

QUALITY-CONTROLS ITS REPUTATION FOR Service IN PLASTICS PROCESSING AND— RECLAMATION

There is one non-secret ingredient in the Plandex formula of service: the RIGHT kind of modern method experience. By the application of the Plandex methods, the whole Plandex organization "signs on the dotted line" to deliver the kind of processing and reclamation you have a right to expect. This is a big-league team equipped with machinery and talent that knows how to please the leaders in the plastics industry.

SORTING • GRINDING
COLORING • BLENDING
COMPOUNDING
PELLETIZING • STRAINING
MASTER BATCHING

In the complex assortment of processing assignments which come to Plandex: Uniform Coloring of Hard-To-Handle Thermoplastics . . . Compounding Special Blends to customers' specific recipes . . . Volatile extraction . . . Test Runs, Pilot Plant Operations, Pioneering Work of Highly Classified Nature . . . and Improved Scrap Recovery of all kinds.

Plandex is as near as your Telephone: ANdrews 9-2130 or Wire or Write:

PLANDEX COMPANY
DOWNINGTOWN, PENNSYLVANIA

Book Reviews

"Engineering Properties and Applications of Plastics." Gilbert Ford Kinney. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. Cloth, 6 by 9¼ inches, 285 pages. Price, $6.75.

This excellently-written work describes the major characteristics of plastics in the order of their increasing complexity. Using a unified treatment rather than a topical approach, the author establishes the necessary principles, concepts, and terminology with the simpler cases. Emphasis is placed on understanding the special nature of plastics, essential knowledge for proper engineering design.

Separate chapters are devoted to plastics classes, and to methods of fabrication. Five other chapters cover the following topics: engineering properties, thermal properties, optical properties, electrical properties, and the chemistry of plastics. Graphs, formulas, and schematic drawings are included.

"Emulsions—Theory and Practice." Paul Becher. Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y. Cloth, 6 by 9 inches, 380 pages. Price, $12.50.

Recent developments in the theory and techniques of emulsification are explained in this new ACS Monograph No. 135. The introduction covers facts and theories of surface chemistry relevant to emulsions, their physical properties, stability, and the various stages of instability to complete demulsification. Other factors discussed include the chemistry of emulsifying agents, emulsifier efficiency, practical formulations, and the commercial aspects of demulsification. Two appendices deal with the measurement of emulsions and emulsion components, and a listing of commercially available emulsifiers.

"Higher Oxo Alcohols." Lewis F. Hatch. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y. Cloth, 6 by 9¼ inches, 130 pages. Price, $4.50.

The avowed purpose of this book is to review the extensive patent literature on the oxo process for producing aldehydes and alcohols from olefins, carbon monoxide, and hydrogen. This reaction has been little noted outside of patent literature and a few papers on the catalyst or the reaction mechanism. Information concerning the industrial utilization of higher oxo alcohols is derived primarily from product bulletins issued by Enjay Co. and Enjay Laboratories.

One chapter is devoted to the performance of plasticizers made with isooctyl and decyl oxo alcohols. Tensile elongation, flexibility, extractability, volatility, heat stability, and electrical properties are considered. Following this is a discussion of plasticizer blends, stabilization of vinyls, and plastisols employing the above-mentioned plasticizers.

"Management for Engineers." Roger C. Heimer. McGraw-Hill Book Co., 330 West 42nd St., New York 36, N.Y. Cloth, 6 by 9¼ inches, 466 pages. Price, $6.75.

Like it or not, the technological age is forcing the engineer into management. Though trained objectively, he must become subjective in relation to production costs, profit and loss, and organizational structures of his firm. Purpose of this book, therefore, is to acquaint the young engineer with the day-to-day workings of a business firm.

The author analyzes the income contributions by engineers in a mythical firm, Z. A. Zalk Equipment Co. A practical look is taken at costs, standards, materials, methods, taxes, insurance, power, equipment, labor, and ethics. Three particularly pertinent chapters as evidenced by their titles, are "Money Flow in the Business Enterprise," "Depreciation," and "The Legal Forms of Business Organization."

"The Pentaerythritols." Evelyn Berlow, Robert H. Barth, and John E. Snow. Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y. Cloth, 6 by 9¼ inches, 324 pages. Price, $10.00.

This ACS Monograph No. 136 surveys and evaluates published literature on pentaerythritol, dipentaerythritol, and tripentaerythritol; the preparation of these polyhydric alcohols; and the properties and uses of their derivatives. First used as raw materials in the field of surface coatings, they have been condensed with polybasic acids to form alkyd and polyester resins. Still other applications include fire-retardant coatings, plasticizers for methylcellulose and ethylcellulose, and as a heat stabilizer for PVC and chlorinated paraffin waxes. Many chemical formulas and tables of physical properties are given, and there is a very extensive bibliography.

Abstracts of Important Articles

Materials

"Effects of Molding Pressure on Properties of Glass-Fiber Reinforced Plastics," S. D. Toner, Irvin Wolock, and F. W. Reinhart, *SPE J.*, 14, 6, 40 (June 1958).

Test results are presented to show that an increase in molding pressure increases the tensile and flexural properties of laminates made in an open mold, but has little effect on properties of laminates made in a closed mold.

"Reinforced Plastics at 3,000 to 25,000° F," M. W. Riley *Materials Design Eng.*, 47, 6, 100 (June 1958).

A review of data on reinforced plastics for use at elevated temperatures.

"A Methylstyrene Molding Compound for the Electronics Industry," H. J. West, *Western Plastics*, 5, 5, 19 (May 1958).

A discussion of Cyanamid's methylstyrene molding compounds, with emphasis on their physical and electrical properties.

Polycarbonate Resin," W. F. Christopher, *SPE J.*, 14, 6, 31 (June 1958).

An SPE 1958 Conference paper describing Lexan resin, its chemistry; dimensional stability; mechanical, thermal, chemical, and electrical properties; injection molding conditions; and potential applications.

"Testing of Plastic Materials and Plastic Products," J. W. Swanson, *Western Plastics*, 5, 6, 25 (June 1958).

A report dealing with methods used in testing physical properties, electrical testing, and thermal testing by means of apparatus available from Delsen Corp.

"Investigations on the Determination of the Acetic Acid Yield of Cellulose Acetate," recorded by C. A. Redfarn, *Plastics, (London)*, 23, 244, 33 (Jan. 1958).

A sub-committee appointed in 1953 by the British Standards Institution to draft a British Standard for methods of analysis of cellulose acetate flake undertook, as one of its first investigations, a critical examination of various possible methods for determining the acetic acid yield of cellulose acetate. The present paper records the results of this examination.

"Radiation Damage to Plastic," D. M. Newell, *SPE J.*, 14, 7, 17 (July 1958).

Results of tests are described and showed that changes in plastics due to radiation dose or dose rate were insignificant. Silicone rubber samples showed lower ultimate elongations, while Teflon specimens increased in strength.

"Cure Shrinkage of Epoxy Systems," H. L. Parry and H. A. Mackay, *SPE J.*, 14, 7, 22 (July 1958).

An investigation of cure shrinkages showed that the use of various curing agent combinations gave lower shrinkages after gelation.

"Tensile Properties of Fractionated High Density Polyethylenes," L. H. Tung, *SPE J.*, 14, 7, 25 (July 1958).

An SPE Conference paper showing that yield strength and tensile modulus of high-density polyethylenes are functions of crystallinity or density only, and are independent of molecular weight and distribution.

"Copolymers, Block, Graft, and Copolymers," E. Farraris, *Materie Plastiche*, 23, 9, 707 (Sept. 1957).

Review of the structure and methods of producing copolymers, with references to the relevant literature and patents. (In Italian.)

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

Request for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines is printed here quarterly.

The next complete listing will appear in October. The last listing appeared in the June issue.

"Properties Required of Thermosets for Automatic Molding," F. J. Donohue, *Modern Plastics*, 35, 11, 104 (July 1958).

Based on an SPE Conference paper, this article shows that automatic thermoset molding requires materials that feed uniformly, are easily preheated, flow well, and cure rapidly.

"Storage Stability of Cellulose Nitrate," G. R. Rugger, *SPE J.*, 14, 7, 29 (July 1958).

Outdoor storage and storage in the dark at 160° F. are harmful, although tests showed that outdoor exposure followed by heated storage is most harmful. Tests also showed that volatile products can initiate degradation of unexposed material.

"Soviet Polymer Science Today," H. F. Mark, *Modern Plastics*, 35, 11, 111 (July 1958).

A report based on observations by the author during a recent visit to Russia.

Equipment

"The Elastomer - A Simple Device for Measurement of Elastic Moduli of Plastics at Elevated Temperatures," R. A. Spurr, M. J. Heldman and Howard Myers, *ASTM Bull.*, No. 231, 65 (July 1958).

Apparatus, test method, and results obtained are given for the new tester. Further studies are proceeding to obtain relative modulus data on different plastic materials at elevated temperatures.

"The Low-Temperature Brittleness Testing of Polyethylene," P. N. Bestelink and S. Turner, *ASTM Bull.*, No. 231, 68 (July 1958).

A new apparatus, subsidiary equipment, test method, and results obtained are given for a new low-temperature brittleness test of polyethylene.

Processing

"Molding Dry-Colored Polyethylene," C. L. Weir, *Modern Plastics*, 35, 11, 97 (July 1958).

Comparing effectiveness of nozzle inserts, a new breaker plate with venturi-shape holes is shown to be effective for extrusion compounding.

"Moisture, Monster of Metallizing, Meets End in Trap," J. A. Selsmeyer and H. M. Farrow, *Modern Plastics*, 35, 11, 109 (July 1958).

A mechanically-refrigerated, quickly defrosted trap system makes metallizing operations independent of humidity and prevents serious production slow-downs.

CADET CHEMICAL CORPORATION

Lockport-Olcott Road
Burt 4, New York

Manufacturers of **ORGANIC PEROXIDES**

BENZOYL PEROXIDE
LAUROYL PEROXIDE
MEK PEROXIDE

2, 4 Dichlorobenzoyl Peroxide

Descriptive Literature Available On Request.

Distributed by

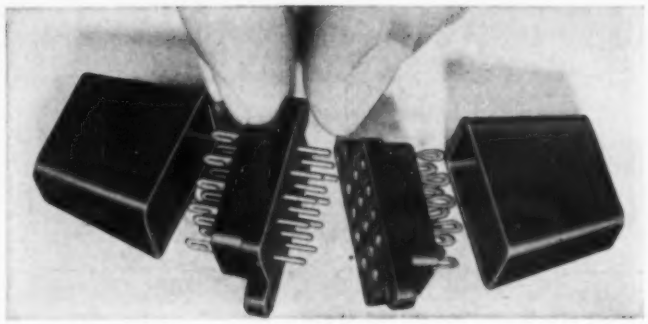
CHEMICAL DEPARTMENT

of

McKESSON & ROBBINS, INC.

155 East 44th St., New York 17, N.Y.

Warehouse Stocks in Principal Cities



"SAVED: OVER $4,000

Making Sub-Min. Plugs on MINI-JECTOR®!"

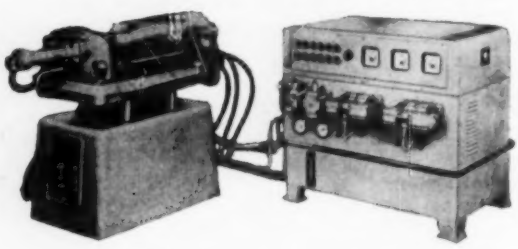
. . . reports Royal Communications, Cleveland. (Details on request.) Hundreds of firms mold precision parts (subminiature to 1 oz.), conventional and "insert", in all thermoplastics *including Nylon*, and *save major* costs with MINI-JECTOR Plastic Injection Molding Machines. From $1,000 (complete); mold blanks low as $29.50. Easy to operate. Send for catalog.

NEWBURY INDUSTRIES, Inc.
Box 984, Newbury, Ohio

AT LAST! An Automatic

BLOW-MOULDING

MACHINE FOR PLASTIC BOTTLES & TOYS



Outstanding Features:

- ☆ Fully Automatic
- ☆ High Speed Production
- ☆ Can be connected to any extruder or furnished with extruder.
- ☆ Produces sizes 5 c.c. to 1 qt.
- ☆ Prompt delivery

Money Saving Factors:

1. Low initial cost
2. Simple, Economical to run
3. Low Mould Cost

WRITE OR SEND COUPON FOR BLOW-O-MATIC CATALOG TODAY

Name .....

Address .....

City ..... Zone ..... State .....

THE BLOW-O-MATIC CORPORATION
Box 9100 Bridgeport 1, Conn. Clearwater 9-6354

WANTED TO BUY: Used injection molding machines, ovens, granulators. One machine or complete plant. Acme Machinery & Mfg. Co., Inc. 20 South Broadway, YOnkers 5-0900, 102 Grove Street, Worcester, Mass. PLeasant 7-7747, 5222 W. North Ave., Chicago, Ill. TUxedo 9-1328.

PLASTICS COMMERCIAL DEVELOPMENT

Top quality men to help rapidly growing strongly research minded company establish a sound position in thermoplastics. Minimum of B.S. and five years experience, preferably with polyolefins and/or styrene. Work will entail market research and all aspects of field development so familiarity with consuming industries essential. Submit detailed resume including education, experience and salary requirements.

Box #7
Plastics Technology
386 Fourth Aveune
New York 16, N.Y.

"Choosing and Forming Polyethylene Sheet," A. G. Rowe, *Modern Plastics*, 35, 12, 113 (Aug. 1958).

The thermoforming properties of polyethylene are shown to be linked to the fundamental characteristics. Heating and cooling rates for various sheet thicknesses were investigated, and a heater bank with twice the usual watt density was found safe.

"The New Polyethylenes," M. W. Riley, *Materials Design Eng.*, 48, 1, 98 (July 1958).

This Part 1 of the article described commercial grades, combinations of properties available, creep and stress-rupture data, and resistance to stress cracking and sterilization.

Applications

"An Application File on Reinforced Epoxy Pipe," H. D. Boggs and E. D. Edmisten, *Western Plastics*, 5, 7, 17 (July 1958).

A repeat of a "Corrosion" article giving general operating data, comparative life and cost data, field problem reports, and a list of applications for reinforced expoxy pipe.

"Plastics in Agriculture-II," R. Pozzo, *Mat. Plastiche*, 23, 9, 715 (Sept. 1957).

In this part is covered chiefly the use of plastic sheets for lining catchments and reservoirs, for protecting seed-beds, and in the construction of silos and domes for temporary milking sheds. Experience in the United States, Canada, and various European countries, as well as in Australia and Japan, is mentioned. (In Italian.)

"Reinforced Plastics as Protective Coating for Wood," Richard Mark and B. M. Zuckerman, *Plastics Industry*, 16, 6, 32 (June 1958).

A testing program is given that concluded with the belief that a complete covering of reinforced plastic prevents decay in kiln-dried wood, regardless of the moisture conditions that prevail during usage.

"The Significance of Plastics Bottles," K. Andree, *Kunststoffe*, 48, 2, 72 (Feb. 1958).

A wide variety of blown polyethylene bottles, flasks and containers is described for a number of uses, from atomizers, baby bottles and fruit-juice bottles to drums and tanks for use in the agricultural, automotive and chemical industries with capacities ranging up to 60 liters. (In German.)

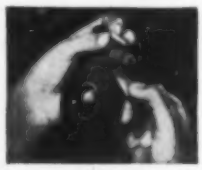
Do you have a

RELEASE PROBLEM?

with

STICKY OR TACKY SURFACES? ...RUBBER? ...PLASTICS? ...FILM CASTING?

Imparts satin-like finish to polyester Fiberglas sheets.



Excellent separator and protective backing for rubber tape.

Patapar Releasing Parchments peel off easily and cleanly. Now available in a variety of new types, these special Patapars have release action that is *"tailored"* to meet each problem. Basic characteristics include: fiber-free texture . . . positive resistance to penetration or migration of oil and softeners . . . inertness to any surfaces they contact . . . permanent releasing action . . . rigidity or flexibility as desired . . . easily printable.

Patapar Releasing Parchments show excellent performance in processes involving synthetic rubber, polyurethane foams, polyesters, vinyl, organic adhesives, organosols, phenolics, acrylics.

Samples and technical assistance are freely available. Just write us, telling your problem.

Patapar®
RELEASING PARCHMENT

HEADQUARTERS FOR VEGETABLE PARCHMENT SINCE 1885

How to reduce your mold costs

D-M-E STANDARD MOLD BASES can reduce your mold costs in the design stage . . . during construction . . . and throughout the operation of the mold.

Mold designers can reduce drawing board time by using D-M-E's full-scale Master layouts, which provide locations of leader pins, return pins, screws and other standard details. Complete catalog specifications and prices on 31 standard sizes—up to 23¾" x 35½"—eliminate guess-work in estimating the cost of the mold.

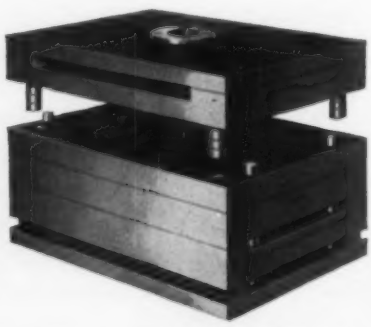
But your savings don't end there: Moldmaking time is turned into dollars earned, because all the plates in the assembly are precision ground—flat and square—ready for the moldmaker's layout and machining (pictured above). The exclusive interchangeability of all D-M-E plates and component parts gives you the added saving of immediate replacement in case of emergency.

For the molder, the use of higher grades of CLEANER steel in D-M-E Mold Bases means added strength and longer mold life. And D-M-E's range of standard sizes fit into *more* molding machines.

Start saving now...with D-M-E STANDARD MOLD BASES!

Over 1000 D-M-E STANDARD MOLD BASES are always IN STOCK at local D-M-E Branches ready for IMMEDIATE DELIVERY

WRITE TODAY FOR 170 PAGE CATALOG

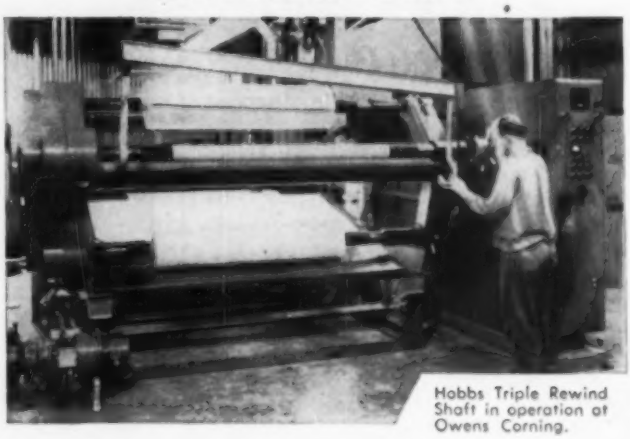


DETROIT MOLD ENGINEERING CO. DME 58-D

6686 E. McNICHOLS ROAD, DETROIT 12, MICHIGAN, TWinbrook 1-1300
Contact Your Nearest Branch For Faster Deliveries!
- HILLSIDE, N.J.: 1217 Central Ave., CHICAGO: 5901 W. Division St. LOS ANGELES: 3700 S. Main St.
- D-M-E CORP., CLEVELAND: 502 Brookpark Rd., DAYTON: 550 Leo St.
- D-M-E of CANADA, TORONTO, ONT.: 156 Norseman Ave.

HOBBS *Winding Stands*

CUSTOM OR STANDARD

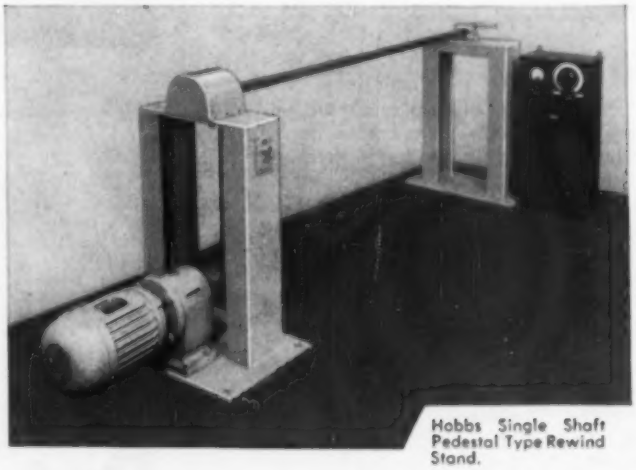


Hobbs Triple Rewind Shaft in operation at Owens Corning.

MAXIMUM WINDING EFFICIENCY For Each Individual Installation

Select your winding stand from standard equipment, including single winding stands, two shaft winding stands and turret winders — or when the problem is highly vertical, get the complete design, engineering and production facilities of the most successful supplier of winding equipment in the U. S. A.

Hobbs Has a Winding Stand for Every Purpose — Standard or Special



Hobbs Single Shaft Pedestal Type Rewind Stand.

EST. 1889

Ask for Special Winding Stand Literature

HOBBS MANUFACTURING CO.

78-I Salisbury St., Worcester 5, Mass.

Branch Offices and Representatives in Irvington, N. J., Chicago, Cleveland, Greenville, S. C. and Toronto, Can.

Patent Digest

Materials

Bis(Salicyloyl) Benzene Derivatives and Compositions Containing the Same. No. 2,824,853. David A. Gordon, Midland, Mich. (to Dow Chemical Co., Midland, Mich.).

A thermoplastic composition comprising a haloethylene polymer and from 0.5-6.0% by weight of ortho-bis (3,4,6-trichlorosalicyloyl) tetra chlorobenzene.

Stopping Agent for Vinyl Chloride Polymerization. No. 2,822,355. Byron H. Werner, Akron, O. (to Firestone Tire & Rubber Co., Akron, O.).

To 100 parts of vinyl chloride in aqueous suspension, 0.05-5 parts of butadiene monoxide are added to arrest the polymerization.

Process for the Production of Melamine. No. 2,826,579. Marion D. Barnes and William P. Donahoo, El Dorado, Ark. (to Monsanto Chemical Co., St. Louis, Mo.).

Melamine is produced by heating a mixture of sulfur, carbon monoxide, ammonia, sulfur dioxide at a temperature between 300-500° C., and at a pressure of at least 500 psig.

Trifluorochloroethylene Copolymers With 4,6,7-Trichloroperfluoroheptene-1. No. 2,826,568. William S. Barnhart, Cranford, and Robert H. Wade, West Paterson, N. J. (to Minnesota Mining and Mfg. Co., St. Paul, Minn.).

Between five mole percent and 95 mole percent of trifluorochloroethylene is copolymerized with between 95 mole percent and five mole percent of 4,6,7-trichloroperfluoroheptene-1 at a temperature between 0-50° C.

Application of Perfluorochloroolefin Polymer Coatings to Base Materials. No. 2,828,236. Fred W. West, Paterson, N. J. (to Minnesota Mining and Mfg. Co., St. Paul, Minn.).

The coating is applied to the base material by interposing between the two a fluid layer comprising the condensation product of epichlorohydrin and a compound selected from the group consisting of polyhydric alcohols and polyhydric phenols. This condensation product has a melting point of at least 0° C., and an epoxy equivalent of at least 150.

Catalytic Polymerization of Olefins. No. 2,828,347. John Paul Hogan and William C. Lanning, Bartlesville, Okla. (to Phillips Petroleum Co., Bartlesville, Okla.).

During polymerization, an olefin feed is contacted with a catalyst consisting of nickel halide-silica-alumina.

Equipment

Machine for Injection-Moulding of Plastic Articles. No. 2,828,508. Maurice Labarre, Paris, France. (to Societe Anonyme dite: Specialities Alimentaires Bourguignonnes (S.A.B.), Dijon, France.).

The machine comprises a fixed injection pump with delivery orifice; a means for storing powdered material and transforming it into liquid; and a vertical rotatable, turntable which bears a plurality of molds.

Apparatus for Indicating the Plastic Deformation of Materials. No. 2,826,062. Guy Lawrence Brown, Griffith, and Robert Peebles McMurrich, Victoria, Australia. (to Commonwealth of Australia, Crown Solicitor's Office, Canberra, Australia.).

The device comprises means for applying a load to a test member and an elastic member, together with an electric strain gage for each. The gages are connected in a bridge circuit, and remain in balance only so long as the deformation load is below the elastic limit of the test specimen. A device is connected to the bridge circuit that responds to changes in its state of unbalance. When the specimen has passed its elastic limit, this device records the extent of plastic deformation in terms of a predetermined percentage of the test strip's original length.

Means for Injecting a Liquid Additive into Another Liquid. No. 2,826,211. Edwin E. Reed, Bartlesville, Okla. (to Phillips Petroleum Co., Bartlesville, Okla.).

This proportioning apparatus comprises a liquid conduit containing a flowmeter, an additive injection line feeding into the conduit, and a three-way valve and pump to govern the flow of injected fluid. A by-pass valve around the three-way unit remains normally open so that pump operation can be continuous even though fluid injection is intermittent. A pair of electrical circuits connect a time delay device for the solenoid with a contact-making unit on the flow-meter. This circuitry acts through the solenoid alternately to position the valve for injection or by-pass.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

Processing

Method of Sizing Nylon Textile Materials With Coal Acid Compounds and Resulting Article. No. 2,826,515. Herbert B. Rickert, Keith B. Bozer, and Robert S. Montgomery, Midland, and Marshall W. Duke, Bay City, Mich. (to Dow Chemical Co., Midland, Mich.).

A plastified film of coal acid compounds is deposited on the surface of nylon yarn in an amount up to 20% by weight. This produces a finish which facilitates weaving of the yarn into fabric.

Method of Continuously Forming Tubing of Plastic Materials. No. 2,828,239. Herbert Corliss Fischer, Wellesley Hills, Mass. (to National Fibre Glass Co., Inc., West Hanover, Mass.).

Phenol-formaldehyde resin-impregnated glass fiber strip material is spirally wound about a rotating, collapsible mandrel. The material is heat-cured to form a hardened tubing which is removed by collapsing the mandrel.

Applications

Expandable Beaded Decorative Printing. No. 2,827,727. Herbert Lipsius, Brooklyn, N. Y.

Relief effects are put on greeting cards by applying a thermosetting adhesive in the shape of the design, and covering this area with an even layer of expandable polystyrene beads. Application of heat sets the adhesive and puffs the beads to a greater size forming a relief design of irregular lace-like appearance.

Synthetic Resin Mounting Joint. No. 2,827,671. James S. Martin, Huntington, N. Y. (to Republic Aviation Corp., Farmingdale, N. Y.).

The mounting member consists of layers of acrylic-filament reinforcing material laminated by impregnation with an acrylic solution. The laminate is secured to the edge of a closure member so as to produce a homogeneous body of the same resin throughout the entire joint.

Patent Digest (Cont'd.)

Antistatic Copolymer of Sulfonated Styrene and Vinyl-Pyridine and Treatment Therewith of Synthetic Shaped Articles. No. 2,829,066. Stanley A. Murdock, Teddy G. Taylor, and Theodore B. Lefferdink, Concord, Calif. (to Dow Chemical Co., Midland, Mich.).

A shaped, synthetic, hydrophobic material is given antistatic treatment by applying a copolymer of sulfonated styrene monomeric material and a vinyl pyridine compound.

Plastic Injection Syringe. No. 2,826,195. David M. Ashkenaz, Bala Cynwyd, Pa. (to American Home Products Corp., New York, N. Y.).

The syringe is fabricated of a light-transmitting, synthetic plastic and consists of a cylindrical barrel, a head, and a push-rod. The barrel is adapted to receive a cartridge containing an injectable drug.

Positions Open

Classified Rates $10.00 per inch.

WANTED: Chemist or Production man experienced in the manufacture and development of Urea and Melamine-Formaldehyde resins for coatings and molding powders. The man we want must be capable of producing and selling these products to the paint and plastics industry. Excellent opportunity for the right man on a profit sharing plan. Location metropolitan New York. Full information in strictest confidence. Write

Box #8
Plastics Technology
386 Fourth Avenue
New York 16, N.Y.

Directory

1 time	$16.50 per inch
6 times	$15.40 per inch
12 times	$13.20 per inch

FOR SALE: 1 oz. Van Dorn Lever Type—$850. 4 oz. Lewis, 1954—$3,000. 4/6 oz. R-P, 1955. 4 oz. vert. DeMattia 8 oz. R-P, 1946—$5,000. 12 oz. W-S Model E—$6,000. 12 oz. Lester w/solid frame—$4,000. 16 oz. vert. Impco 48 oz. W-S 1950 Model #246 Vactrim. Ovens, Grinders, Powder Mixers, Injection Molding Machines 1 oz. to 60 ozs. never used and used. Acme Machinery & Mfg. Co., Inc., 20 South Broadway, Yonkers, N.Y., YOnkers 5-0900; 102 Grove Street, Worcester, Mass., PLeasant 7-7747; 5222 W. North Ave., Chicago, Ill., TUexedo 9-1328.

Current Market Prices

Price Changes and Additions

Catalysts			
Nuodex Benzyol peroxide 50% paste	lb.	$0.91 /	$2.25
Benzoyl peroxide, 96%, dry	lb.	.98 /	2.00
Cobalt accelerator	lb.	.4875/	3.85
Lauroyl peroxide	lb.	1.90 /	3.50
Manganese accelerator	lb.	.2975/	2.65
M.E.K. peroxide, 60%	lb.	1.96 /	4.00
Paramenthane hydroperoxide, 54%	lb.	.535 /	.55
Silicone catalyst 1, 2	lb.	2.90 /	4.50
Colors			
Cabot carbon blacks:			
Black pearls 2	lb.	.78 /	.87
71	lb.	.36 /	.44
74	lb.	.26 /	.34
81	lb.	.0975/	.17
0	lb.	.135 /	.21
Carbolac 2	lb.	.78 /	.87
Elf 0	lb.	.135 /	.21
Elftex 3, 5, 8	lb.	.0825/	.145
Monarch 71	lb.	.36 /	.44
74	lb.	.26 /	.34
81	lb.	.1025/	.18
Sterling R	lb.	.0625/	.125
S	lb.	.0575/	.115
99	lb.	.0725/	.13
Supercarbovar	lb.	.53 /	.61
Fillers			
Cab-o-sil	lb.	.67 /	.85
Wollastonite F-1	ton	27.00 /	29.00
P-1	ton	25.00 /	27.00
Stabilizers			
Nuostabe V-1	lb.	.55 /	.60
V-2	lb.	.36 /	.41
V-10	lb.	.67 /	.80
V-12	lb.	.5525/	.6825
V-14	lb.	.39 /	.52
V-20	lb.	1.27 /	1.40
V-21	lb.	1.07 /	1.20
V-40	lb.	1.25 /	1.38
V-50	lb.	.46 /	.59
V-60	lb.	.39 /	.44
V-82	lb.	2.37 /	2.50
V-122	lb.	.84 /	.91
V-130	lb.	.87 /	.94
V-131, V-171	lb.	.72 /	.79
V-132	lb.	.67 /	.74
V-133	lb.	.97 /	1.04
V-141	lb.	.57 /	.64
V-142	lb.	.81 /	.88
V-152	lb.	.62 /	.69
V-183	lb.	2.50 /	2.79
V-205	lb.	.78 /	1.58
Wetting Agents			
Nuosperse 657	lb.	.48 /	.56

CALENDAR of COMING EVENTS

Sept. 22-24
Seventh Annual Meeting, Standards Engineers Society, Benjamin Franklin Hotel, Philadelphia, Pa.

Sept. 25
Chemical Industry Safety Workshop. Manufacturing Chemists' Association and Texas Chemical Council. Shamrock Hilton Hotel, Houston, Tex.

Sept. 29-Oct. 3
ASTE Semi-Annual Meeting and Western Tool Show. Shrine Exposition Hall, Los Angeles, Calif.

Oct. 1
SPE Western New England Section. Regional Technical Conference. Plastics in Packaging. Hotel Statler, Hartford, Conn.

Oct. 9-10
SPI 14th New England Section Conference. Wentworth-by-the-Sea, Portsmouth, N. H.

Oct. 20-22
13th Tappi Plastics-Paper Conference. Sheraton-Kimball Hotel, Springfield, Mass.

Oct. 21
SPE Upper Midwest Section. Regional Technical Conference. Epoxies. Curtis Hotel, Minneapolis, Minn.

Oct. 24
SPE Golden Gate Section. Regional Technical Conference. Plastics and Electronics. (Location unannounced.)

Oct. 30-31
International Symposium on Plastics Testing and Standardization. ASTM Committee D-20. Benjamin Franklin Hotel, Philadelphia, Pa.

Nov. 5-6
Annual Fall Meeting, Society of Vacuum Coaters, Hotel Statler, Detroit, Mich.

Nov. 13
SPE Southern California Section. Regional Technical Conference. Plastics in Building and Construction. Ambassador Hotel, Los Angeles, Calif.

Nov. 17-21
Eighth National Plastics Exposition. Int'l Amphitheatre, Chicago, Ill.

Domestic Production and Sales of Plastics and Resin Material, April and May, 1958

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of April and May, 1958. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

Total production and sales figures still maintain their upward trend, and April sales have exceeded those for the same period last year. Cellulosics are off slightly with respect to last month, but phenolics, ureas, and styrenes are holding their gains. Vinyls seem to have leveled off, while coumarones, polyesters, and polyethylenes move on to higher volumes.

	April, 1958		May, 1958	
	Production	Sales	Production	Sales
Cellulose Plastics:[1]				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,275,525	1,275,286	1,343,758	1,380,807
Sheets, 0.003 gage and over	1,777,597	1,410,181	1,535,695	1,431,515
All other sheets, rods, and tubes	699,039	590,597	721,142	589,507
Molding and extrusion materials	6,452,302	6,093,484	6,191,831	6,365,027
Nitrocellulose sheets, rods, and tubes	228,650	275,027	246,485	270,764
Other cellulose plastics	775,071	511,775	768,861	503,278
TOTAL	11,208,184	10,156,350	10,807,772	10,540,898
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	10,727,605	11,514,733	11,726,440	11,451,030
Bonding and adhesive resins for—				
Laminating (except plywood)	4,473,330	2,650,601	4,128,782	2,763,128
Coated and bonded abrasives	1,054,929	841,529	817,809	812,974
Friction materials (brake linings, clutch facings, and similar materials)[2]	766,687	743,362	846,595	636,070
Thermal insulation (fiber glass, rock wool)	3,845,420	3,459,187	3,960,043	4,328,702
Plywood	4,021,753	3,783,864	4,060,612	3,318,577
All other bonding and adhesive uses	2,836,308	2,888,140	2,434,572	2,452,273
Protective-coating resins, unmodified and modified except by rosin	2,352,896	1,938,030	2,084,589	1,990,584
Resins for all other uses	1,677,437	1,410,322	2,245,751	1,829,273
TOTAL	31,756,365	29,229,768	32,305,193	29,582,611
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	2,732,453	2,424,700	2,558,518	2,344,326
Paper-treating and paper-coating resins	2,153,622	1,757,391	1,811,767	1,668,312
Bonding and adhesive resins for—				
Laminating	2,688,262	2,180,273	2,769,930	1,754,561
Plywood	6,415,725			
All other bonding and adhesive uses	634,823			
Plywood	2,688,262	2,180,273	2,769,930	1,754,561
All other bonding and adhesive uses, including laminating	6,415,725	7,149,073	7,203,613	7,885,810
Protective-coating resins, straight and modified	2,062,556	1,799,458	2,225,374	1,834,467
Resins for all other uses, including molding	7,612,110	6,622,793	7,894,319	6,805,120
TOTAL	24,299,551	22,626,416	25,436,704	23,117,794
Styrene Resins:				
Molding materials[1]	36,260,363	37,645,917	36,372,131	42,555,808
Protective-coating resins, straight and modified	6,744,214	7,408,435	7,297,670	7,497,043
Resins for all other uses	12,098,173	10,286,202	12,142,486	9,705,729
TOTAL	55,102,750	55,340,554	55,812,287	59,758,580
Vinyl and Vinyl Chloride Resins:[3]				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		5,424,027		5,810,558
Sheeting (resin content)		4,642,995		5,054,177
Molding and extrusion (resin content)		15,704,906		15,957,969
Textile and paper treating and coating (resin content)[3]		3,880,560		4,768,873
Flooring (resin content)		9,079,490		10,346,689
Protective coating (resin content)		2,064,268		2,517,929
All other uses (resin content)		5,287,100		5,518,631
All other vinyl resins for—				
Adhesives (resin content)		4,086,958		3,674,207
All other uses (resin content)		9,695,572		9,148,997
TOTAL	54,435,676	59,865,876	56,787,984	62,798,030
Coumarone-Indene and Petroleum Polymer Resins	20,065,799	18,814,767	18,881,231	19,208,997
Polyester Resins:				
For reinforced plastics	9,220,878	8,670,937	9,912,640	9,051,496
For all other uses	745,141	829,715	955,603	989,192
TOTAL	9,966,019	9,500,652	10,868,243	10,809,773
Polyethylene Resins:				
For film		26,557,780		23,669,760
For all other uses		42,628,460		37,914,307
TOTAL	66,812,933	69,186,240	70,963,345	61,584,067
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[1, 4]	2,616,412	2,924,219	3,221,296	3,226,929
Protective-coating resins[5]	955,788	723,493	1,160,407	713,675
Resins for all other uses[6]	12,696,512	10,983,351	12,612,372	10,809,773
TOTAL	16,268,712	14,631,063	16,994,075	14,750,377
GRAND TOTALS	289,915,989	289,351,686	298,856,834	291,382,042

[1]Includes fillers, plasticizers, and extenders.
[2]Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3]Includes data for spreader and calendering-type resins.
[4]Includes data for acrylic, nylon, silicone, and other molding materials.
[5]Includes data for epichlorohydrin, acrylic, silicone, and other protective-coating resins.
[6]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.
Included with "All other bonding and adhesive uses."
SOURCE: United States Tariff Commission, Chemical Division.

INDEX TO ADVERTISERS*

SEPTEMBER, 1958

Acheson Dispersed Pigments Company 787
Agency: John Mather Lupton Company, Incorporated

Advance Solvents & Chemical Company
Division of Carlisle Chemical Works, Incorporated 861
Agency: Leonard Advertising Agency

Amoco Chemicals Corporation 794
Agency: D'Arcy Advertising Company

Argus Chemical Corporation 802
Agency: Geer Du Bois & Company, Incorporated

Bakelite Company
Division of Union Carbide Corporation 796-7
Agency: Richard La Fond Advertising, Incorporated

Barber-Colman Company 790
Agency: Howard H. Monk & Associates, Incorporated

The Blow-O-Matic Corporation 866
Agency: Rosner-Lewis, Agency

Cadet Chemical Company 866

Celanese Corporation of America
Chemical Division 791
Plastics Division 803
Agency: Ellington & Company, Incorporated

Columbian Carbon Company 855
Agency: Donahue & Coe, Incorporated

Davis-Standard
Division of Franklin Research Corporation 772
Agency: S. Gunnar Myrbeck & Company, Incorporated

Detroit Mold Engineering Company 868
Agency: Holden, Chapin, LaRue, Incorporated

Frank W. Egan & Company
Plastics Division 792
Agency: Johnson-Bartnett

Escambia Chemical Corporation 798
Agency: Godwin Advertising Agency

The Glidden Company
Chemical-Pigments-Metals Division 799
Agency: Meldrum & Fewsmith, Incorporated Advertising

B. F. Goodrich Chemical Company ..... Third Cover
Agency: The Griswold-Eshleman Company

W. R. Grace & Company
Polymer Chemical Division 859
Agency: Kelly Nason, Incorporated

The Harshaw Chemical Company ..... Fourth Cover

Hartig Extruders 846-7
Agency: Sanger-Funnell, Inc.

Hercules Powder Company 786
Agency: Fuller & Smith & Ross, Incorporated

Hobbs Manufacturing Company 868
Agency: George T. Metcalf Company, Advertising

Improved Machinery 788
Agency: Hillsborough Advertisers

Industrial Research Laboratories 844
Agency: Boylhart, Lovett & Dean

Metal & Thermit Corporation 771
Agency: Raf Advertising, Incorporated

Metasap Chemical Company
Nopco Chemical Industrial Division 852
Agency: Gray & Rogers

Modern Plastics Machinery Corporation 795
Agency: Byrde, Richard & Pound

National Lead Company 801
Agency: Marschalk and Pratt, Division of McCann-Erickson, Incorporated

National Rubber Machinery Company 784
Agency: Ralph Gross Advertising, Incorporated

Newbury Industries, Incorporated 866
Agency: Baisch Advertising Agency

Paterson Parchment Paper Company 867
Agency: Grant & Wadsworth, Incorporated

Phillips Chemical Company 777
Agency: Lambert & Feasley, Incorporated

Plandex Company 862
Agency: John Miller Advertising Agency

Plastics Engineering Company 775
Agency: Kuttner & Kuttner, Incorporated

The Prodex Corporation 857
Agency: Charles Mackenzie, Advertising

Reichhold Chemicals, Incorporated 793
Agency: MacManus, John & Adams, Incorporated

Rohm & Haas Company 776
Agency: Arndt-Preston-Chapin-Lamp & Keen, Incorporated

Rubber Corporation of America 849
Agency: Ovesey and Straus, Incorporated

Semet Solvay Petrochemical Division 845
Allied Chemical Corporation
Agency: Atherton & Currier, Incorporated

Shell Chemical Corporation ..... Second Cover
Agency: J. Walter Thompson Company

Titanium Pigments Corporation 783
Agency: Doyle, Kitchen & McCormick, Incorporated

Union Carbide Corporation
Bakelite Division 796-7
Agency: Richard La Fond Advertising, Incorporated

U. S. Industrial Chemicals Company
Polyethylene Division 779-780-1-2
Agency: G. M. Basford Company

U. S. Mica Company 853
Agency: Terrill Belknap Marsh Associates, Agency

R. T. Vanderbilt Company, Incorporated 854
Agency: H. Edward Oliver

John Waldron Corporation 778
Agency: Sanger-Funnell, Incorporated

Welding Engineers Incorporated 804
Agency: John Miller Advertising Agency

*This is published as a service only. Publisher assumes no liability for errors or omissions.

Another new development using

B.F.Goodrich Chemical *raw materials*

"Dish-Quick" all purpose spray and dishwasher made by Modern Faucet Mfg. Co., Los Angeles, California, uses hose made by Extruded Products Division, Stillman Rubber Company, Fullerton, California. Hose has synthetic rubber inner lining, nylon cord, and Geon polyvinyl jacket. B.F.Goodrich Chemical Company supplies the Geon polyvinyl materials only.

Geon jacket insulates faucet hose against kitchen corrosion

Who'd guess that a kitchen sink would be a tough place for rubber hose to perform? Experience proves that kitchen chemicals and grease will decompose a conventional rubber hose. The problem was solved with a jacket made from Geon polyvinyl materials.

Now the hose has excellent chemical, grease and abrasion resistance. There is less tendency to kink. And, thanks to versatile Geon, color can be built right in. Yet the heat resisting properties of rubber have been retained.

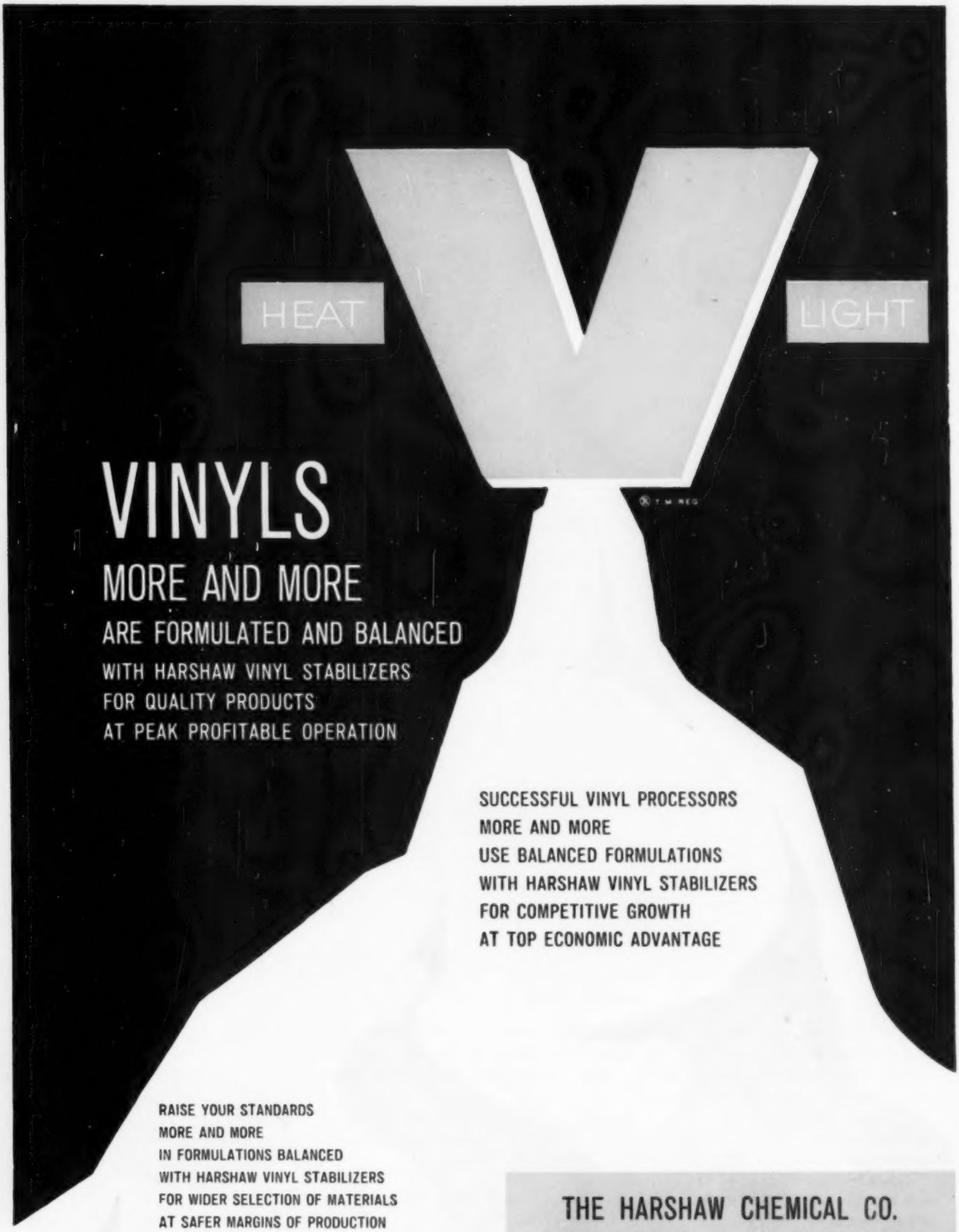
Here's another example of how you can open new markets or build a dramatic new or improved product with Geon polyvinyl materials. For more information, write Dept. LG-5 B. F. Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

B. F. Goodrich Chemical Company
a division of The B.F.Goodrich Company

SEE US AT BOOTH NO. 509
8TH NATIONAL
PLASTICS EXPOSITION
NOV. 17-21
INT'L AMPHITHEATRE - CHICAGO

B.F.Goodrich

GEON polyvinyl materials • HYCAR American rubber and latex
GOOD-RITE chemicals and plasticizers • HARMON colors


HEAT
LIGHT
VINYLS
MORE AND MORE
ARE FORMULATED AND BALANCED
WITH HARSHAW VINYL STABILIZERS
FOR QUALITY PRODUCTS
AT PEAK PROFITABLE OPERATION
SUCCESSFUL VINYL PROCESSORS
MORE AND MORE
USE BALANCED FORMULATIONS
WITH HARSHAW VINYL STABILIZERS
FOR COMPETITIVE GROWTH
AT TOP ECONOMIC ADVANTAGE
RAISE YOUR STANDARDS
MORE AND MORE
IN FORMULATIONS BALANCED
WITH HARSHAW VINYL STABILIZERS
FOR WIDER SELECTION OF MATERIALS
AT SAFER MARGINS OF PRODUCTION
THE HARSHAW CHEMICAL CO.
1945 E. 97th Street • Cleveland 6, Ohio
CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES
HASTINGS-ON-HUDSON, N.Y. • PHILADELPHIA • PITTSBURGH